Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish ALGEBRA Z GEOMETRIĄ ANALITYCZNĄ
Name of subject in English ALGEBRA AND ANALYTIC GEOMETRY
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30	45			
Number of hours of total student workload (CNPS)	75	50			
Form of crediting	Examination / ~~crediting with grade*~~	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	3	2			
including number of ECTS points for practical classes (P)		2			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,44	1,88			

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Knowledge and skills of high school graduate

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SUBJECT OBJECTIVES

C1 Getting acquainted with complex numbers, polynomials, analytic geometry, linear algebra
C2 Performing calculations in the field of complex numbers, polynomials; analytic geometry and linear algebra

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 knows complex numbers, basic properties of the field of complex numbers, calculational methods with complex numbers.

PEU_W02 knows equations of selected subsets of the plane and of the space: line, plane, conical curves. Knows how to calculate distances from points to lines or planes.

PEU_W03 knows basic notions of algebra applied to solve (in real and complex numbers) systems of linear equations. Knows basic notions of the theory of matrices and their connections with systems of linear equations, linear spaces, and linear mappings.

relating to skills:

PEU_U01 can calculate with complex numbers.

PEU_U02 can calculate with vectors; can find equations of lines, planes, selected curves; can calculate the distance from a point to a line or to a plane, knows how to express perpendicularity in analytic terms.

PEU_U03 can calculate with matrices, can calculate determinants, solve linear equations, can find matrix representations of linear mappings.

relating to social competences:

PEU_K01 sees mathematical (algebraic) techniques as practical and theoretical tools for engineering.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Basics. Notation and language of algebra. Mathematical induction	2
Lec 2	Complex numbers; basic algebraic operations, complex conjugate, quadratic equations	2
Lec 3	Complex numbers; complex plane, trigonometric form of a complex numer, de Moivre's formula, taking roots of a complex number	2
Lec 4	Complex numbers; exponential form of a complex numer, complex exponentiation	2
Lec 5	Polynomials. Division of polynomials, remainder; Bezout's theorem; Fundamental Theorem of Algebra, decomposition of real polynomials	2
Lec 6	Geometry. Coordinates of a point and of a vector, the length of a vector, adding vectors, scalar product, perpendicular projection of a vector onto a vector and onto a plane	2
Lec 7	Geometry. Equations of lines, planes, and selected curves	2
Lec 8	Matrices. Algebraic operations on matrices – addition, multiplication, multiplication by a scalar. Transpose and inverse of a matrix	2
Lec 9	Linear space, linear subspace, linear closure of a subset of a linear space	2

Lec 10	Linear independence, basis of a linear space, existence of a basis, the same cardinality of bases	2
Lec 11	Linear mappings, matrix of a linear mapping, the kernel, and the image of a linear mapping – how their dimensions are related, rank of a matrix	2
Lec 12	Determinants; Laplace expansion	2
Lec 13	Elementary operations on matrices; Gauss method of finding the inverse of a matrix; Gauss method of calculating a determinant; Gauss method of solving a system of linear equations	2
Lec 14	Determinant's method of solving a system of linear equations. Cramer's formulas	2
Lec 15	Change of basis; change of basis matrix	2
	Total hours	45

Classes		**Number of hours**
Cl 1-3	Basic operations on complex numbers. Complex conjugate, absolute value (modulus), quadratic equation, systems of linear equations	6
Cl 4-6	Algebraic representation of subsets of the complex plane; exponential and trigonometric forms of a complex numer. Taking powers and roots of a complex number	6
Cl 7-8	Polynomials, division of polynomials, decompositions of polynomials	3
Cl 8-10	Operations on vectors; equations of conical curves	6
Cl 11-13	Matrices of linear mappings	6
Cl 14-17	Multiplication of matrices; finding the inverse of a matrix; calculating determinants	6
Cl 18-20	Solving systems of linear equations using various methods	6
Cl 21-23	Calculating eigenvalues and eigenvectors	6
	Total hours	45

TEACHING TOOLS USED

N1. Lecture using board

N2. Solving exercises with students

N3. Consulting

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_U01 PEU_U02 PEU_U03 PEU_K01	test
F2	PEU_W01 PEU_W02 PEU_W03	exam
P = F1+F2		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE:
[1] Gilbert Strang, Linear Algebra and Its Applications, Cengage Learning, 2005 [2] S.J. Leon. Linear Algebra with Applications. New Jersey: Prentice Hall, 1998.
SECONDARY LITERATURE:
[1] A. Kostyrkin, Wstęp do algebry, PWN (optional, for Polish speaking students)
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
prof. dr hab. Michał Morayne (michal.morayne@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish ANALIZA MATEMATYCZNA 1.1 A
Name of subject in English MATHEMATICAL ANALYSIS 1.1 A
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30	45			
Number of hours of total student workload (CNPS)	100	75			
Form of crediting	Examination / ~~crediting with grade*~~	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	4	3			
including number of ECTS points for practical classes (P)		3			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,44	1,88			

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. W: Knowing mathematics corresponding to the high school diploma on the extended level
2. U: Mathematical skills corresponding to the high school diploma on extended level

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SUBJECT OBJECTIVES

C1 Learning the basic methods of analysing functions of one real variable
C2 Learning the concept of indefinite integral and methods of determining the indefinite integral
C3 Learning practical applications of mathematical analysis

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Student knows the basic terms and theorems of calculus which are used to analyse functions of one real variable.

PEU_W02 Student knows the concept of indefinite integral and methods of determining the indefinite integrals of particular functions.

relating to skills:

PEU_U01 Student is able to analyse simple functions.

PEU_U02 Student is able to calculate indefinite integrals of particular functions.

relating to social competences:

PEU_K01 Student understands the influence of differential and integral calculus on development of technical civilization.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Introduction (the purpose of the lecture). Mathematical notation (Boolean operators, quantifiers), elements of set theory, real numbers, subsets of the set of real numbers (intervals, rays)	2
Lec 2	Basic properties of functions (injection function, monotonic function). Composition of functions. Inverse function. Power and exponential functions and their inverses. Properties of the logarithm	2
Lec 3	Trigonometric functions and their inverse functions. The graphs of trigonometric functions and their inverse functions	2
Lec 4	Sequences and limits of sequences. Basic formulas and theorems. The number *e*. Improper limits	2
Lec 5	Limit of a function at a point. One-sided limits of a function. Asymptotes of a function	2
Lec 6	Continuity of a function at a point and on an interval. Basic properties of continuous functions. Approximate solution of equations. One-sided continuity. Types of discontinuity points	2
Lec 7	The derivative of a function. Basic properties and theorems. Geometric and physical interpretation of the derivative. Mean Value Theorem. The rule of de L'Hospital	2
Lec 8	Extrema of functions, monotonicity on intervals. Derivatives of higher orders. Convexity of a function	2
Lec 9	Analysing functions	2
Lec 10	Determining of largest and smallest value of a continuous function on a closed interval; applications	2
Lec 11	Taylor's formula. Approximation of a function. Applications	2
Lec 12	Indefinite integral: basic formulas	2
Lec 13	Methods of calculating integrals I: integration by parts and by substitution	2
Lec 14	Methods of calculating integrals II: simple rational functions, trigonometric substitutions	2
Lec 15	Methods of calculating integrals II: simple irrational functions	2
	Total hours	30

Classes		Number of hours
Cl 1-2	Tautologies, de Morgan's laws, union, intersection of sets and the complement of a set	4
Cl 3	Natural, integer, rational and real numbers. Expotentiation and logarithm	2
Cl 4	Graphs of simple functions. Inverse function. Composition of functions	2
Cl 5-6	Trigonometric functions and trigonometric identities.	4
C1 7-8	Limits of sequences	3
C1 8-9	Limits of function at a point	3
C1 10	Continuous functions. One-sided continuity, points of discontinuity	2
C1 11	Theorems about continuous functions and their applications	2
C1 12-13	Derivative of a function at a point. Equation of the tangent to a function at a point	3
C1 13-14	Calculation of derivatives of functions. Determining the intervals of monotonicity of functions and local extrema	3
C1 14-16	Determining the largest and the smallest value of a continuous function on a closed interval	4
C1 17-19	Taylor's formula. De L'Hospital's rule - calculation of limits of functions	4
C1 20-21	Determining indefinite integrals by the method of integration by parts and by substitution	3
C1 21-22	Integration of rational functions. Integration of trigonometric functions	4
C1 23	Integration of irrational functions	2
	Total hours	45

TEACHING TOOLS USED
N1. Lecture – traditional method N2. Classes – traditional method N3. Student's own work with the use of mathematical packages

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_U01 PEU_U02 PEU_K01	Tests, oral answers
F2	PEU_W01 PEU_U02	Exam
P Exam		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Stewart, J., Calculus: Early Transcendentals (8th Edition), Cengage Learning, 2015 **SECONDARY LITERATURE:** [1] Bers, L., Calculus, Holt, Rinehart and Winston, 1969
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
prof. dr hab. Michał Morayne (michal.morayne@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish ANATOMIA DLA INŻYNIERÓW BIOMEDYCZNYCH
Name of subject in English ANATOMY FOR BIOMEDICAL ENGINEERS
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30				
Number of hours of total student workload (CNPS)	50				
Form of crediting	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	2				
including number of ECTS points for practical classes (P)					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,28				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

None

SUBJECT OBJECTIVES

C1 Acquiring knowledge about the basic conceptual categories related to human anatomy, body structure and foundations of the functioning of the human body
C2 Acquiring basic knowledge about the structure of the human body at the cellular, tissue, individual organs and the entire body levels
C3 Acquiring knowledge of the topology of organs and body systems
C4 Acquiring basic knowledge of the use of Biomedical Engineering methods in the study of anatomy and completing or substituting the functions or parts of individual organs

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 knows and understands the basic concepts of Anatomy.

PEU_W02 has extended knowledge of the morphology and topology of human organs.

PEU_W03 has ordered general knowledge, covering issues related to the structure of the human body at the cellular, tissue and organ levels.

PEU_W04 has knowledge of the use of biomedical engineering methods in the anatomy study and in the supporting or substituting of human organs.

relating to skills:

PEU_U01 is able to obtain information from literature, databases and other sources, is able to correctly interpret, select and combine the obtained information, is able to apply the obtained information in practice, in particular, is able to prepare a paper on a given topic concerning the use of biomedical engineering methods in enhancing / replacing the functions of human organs.

PEU_U02 is able to draw conclusions, formulate and justify opinions, in particular in the field of knowledge of Anatomy.

relating to social competences:

PEU_K01 can interact and cooperate in a group, taking various roles in it, is ready to think and act in an entrepreneurial way.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Introduction. History. The role of biomedical engineering in the study of Anatomy.	1
Lec 2	Basic anatomical terminology. Anatomic topography. Body planes and directions.	1
Lec 3	Fundamentals of the structure and functions of the organism. Organization of the Human Body. Components of the human body.	1
Lec 4	Anatomy at the micro and nano level. Cellular and subcellular structures.	3
Lec 5	Osteology and arthrology. Structure and function of bone tissue. Construction and types of joints.	2
Lec 6	Structure of the upper and lower limbs. The role of biomedical engineering in supplementing the body's functions.	2
Lec 7	Spine, skull, chest bones−structure, functions in the body.	2
Lec 8	Structure and functions of skin and muscles.	2
Lec 9	3D printing of body parts and prostheses.	1
Lec 10	Anatomy of thorax. Respiratory system.	2
Lec 11	Anatomy of abdominal cavity. Digestive system.	3
Lec 12	Heart and circulatory system. The role of biomedical engineering in improving the functions.	4
Lec 13	Urinary tract.	1
Lec 14	The brain and nervous system.	3
Lec 15	Anatomy of the reproductive system, methods of examination of the genital organs and monitoring of the fetus.	2
	Total hours	30

TEACHING TOOLS USED
N1. Multimedia lectures N2. Tests of knowledge N3. Teaching kits, anatomic specimens (models and natural ones) N4. Individual consultations

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02 PEU_W03 PEU_W04	Online tests
F2	PEU_U01 PEU_U02 PEU_K01 PEU_K02	Data bases search Independent preparation as a group work of a presentation on a given topic related to the enhancement/substituting of human organs Online test
P – lecture – final grade is the average of multiple tests performed during the semester. Elaboration of an essay based on the most recent papers published in a relevant scientific journal, is required.		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE:
[1] Anatomy and Physiology online https://openstax.org/details/books/anatomy-and-physiology [2 Free Anatomy eBooks Online https://www.topfreebooks.org/free-anatomy-ebooks-online/
SECONDARY LITERATURE:
[1] Anatomy atlas [2] Databases e.g., Medline, PubMed etc.
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
prof. dr hab. inż. lek. med. Halina Podbielska (halina.podbielska@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish: FIZYKA 1
Name of subject in English: PHYSICS 1
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st/ ~~2nd level, uniform magister studies~~*, full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional / university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	45	30			
Number of hours of total student workload (CNPS)	75	50			
Form of crediting	Examination / ~~crediting with grade~~*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	3	2			
including number of ECTS points for practical classes (P)		2			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	2,04	1,28			

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Successful completion of the matriculation examination in subjects Mathematics and Physics with astronomy in the extended range

SUBJECT OBJECTIVES

C1. Acquisition of basic knowledge, considering application aspects, of the following branches of classical physics:
- C1.1. Dynamics
- C1.2. Gravitational field
- C1.3. Hydrodynamics of fluids
- C1.4. Vibrational and wave motion
- C1.5. Thermodynamics
- C1.6. Electrostatics

C1.7. Continuous electric current

C2. Gain skills in qualitative and quantitative analysis of phenomena/processes and solving problems/tasks related to the above-mentioned branches of physics.

C3. To develop and consolidate mainly soft social skills, including understanding the need for continuous learning, and the ability to:

C3.1 to critically evaluate one's knowledge and perceive the importance of knowledge in solving cognitive problems,

C3.2 to determine priorities and make decisions independently and to critically evaluate undertaken and completed own actions related to, among others, studying,

C3.3 take personal responsibility for the consequences of their own actions,

C3.4 work in a group.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 has basic knowledge of Newton's dynamics principles of progressive and rotational motion, methods of solving equations of motion and application of dynamics laws in physics and engineering practice.

PEU_W02 has well-established knowledge of the principles of conservation of momentum, mechanical energy, angular momentum, conditions of their correct application in physics and engineering practice.

PEU_W03 has well-ordered knowledge of properties of gravitational fields, methods of their quantitative description and motion of bodies in such fields.

PEU_W04 has well-established knowledge of hydrodynamics of fluids.

PEU_W05 knows physical properties of vibrating and wave motion, methods of quantitative characterization of vibrations and waves and their applications in engineering activities.

PEU_W06 knows and understands the basics of phenomenological thermodynamics, has knowledge of selected issues of statistical thermodynamics and methods of applying this knowledge to analysis of thermodynamic phenomena and processes.

PEU_W07 has a thorough knowledge of properties of electrostatic fields, direct electric current and methods of applying this knowledge to analysis of engineering problems.

relating to skills:

PEU_U01 can independently present in a written or oral form correctly and concisely issues that are the subject of learning outcomes PEU_W01-PEU_W07.

PEU_U02 can qualitatively and quantitatively analyze and solve uncomplicated equations of progressive and rotational motion of bodies.

PEU_U03 has the ability to correctly apply the principles of behavior defined PEU_W02 to analyze and solve selected physical and engineering tasks and problems.

PEU_U04 is able to qualitatively and quantitatively characterize scalar and vector properties of weak gravitational fields and motion of bodies in these fields.

PEU_U05 has the ability to analyze and solve tasks and problems related to fluid hydrodynamics.

PEU_U06 is able to qualitatively and quantitatively describe properties and effects related to vibrating motion, mechanical waves and solve tasks related to vibrations and waves.

PEU_U07 is able to analyze and solve tasks/problems in phenomenological and statistical thermodynamics.

PEU_U08 knows how to quantitatively characterize scalar and vector properties of

electrostatic fields and to analyze and solve problems concerning electrostatics and direct electric current.

relating to social competences:

PEU_K01 understands the necessity of continuous education; can make a critical assessment of the possessed knowledge and perceive the significance of knowledge in solving cognitive problems (K6IBM_K01)

PEU_K02 can independently determine priorities and make decisions, critically evaluate own actions taken and completed, related to e.g. studying, and accept personal responsibility for the consequences of their actions (K6IBM_K03)

PEU_K03 is able to work in a group and communicate with the social environment (K6IBM_K05).

PROGRAMME CONTENT		
Lecture		**Number of hours**
Lec 1	Organizational matters. Methodology of physics	2
Lec 2-4	Newton's principles of dynamics	5
Lec 4-6	Work and mechanical energy. Principle of conservation of mechanical energy	5
Lec 7-8	Principles of conservation of momentum and angular momentum	4
Lec 9	Gravity	2
Lec 10	Hydrodynamics	2
Lec 11-14	Vibrating motion and mechanical waves. Sounds	8
Lec 15-18	Phenomenological thermodynamics with elements of statistical physics	8
Lec 19-21	Electrostatics	6
Lec 22-23	Direct current	3
	Total hours	45

Classes		**Number of hours**
Cl 1-2	Organisational matters. Application of Newton's principles to the solution of equations of motion; determination of the time dependence of kinematic and dynamic values in inertial and non-inertial reference systems.	4
Cl 3	Solving selected problems in the dynamics of motion using: mechanical work, kinetic and potential energy, the work-energy theorem and the principle of conservation of mechanical energy.	2
Cl 4	Analyse and solve tasks/problems involving elastic and inelastic collisions using the laws of conservation of kinetic energy and momentum.	2
Cl 5	Solving tasks involving the dynamics of rotational motion of a rigid body using conservation of angular momentum.	2
Cl 6-7	Quantitative and qualitative analysis of selected gravitational field physics problems concerning the determination of: a) vector (intensity) and scalar (potential) gravity field quantities (application of Gauss's theorem),	4

	b) gravitational force values, c) potential energy. Solving tasks related to statics and fluid dynamics with reference to the properties of blood flow.	
Cl 8-9	Analysis and solution of tasks in the dynamics of oscillatory motion simple harmonic, damped, forced and mechanical resonance.	4
Cl 10-11	Analysing and solving selected tasks/problems relating to the basic properties of mechanical and acoustic waves, in particular connected with the transport of energy by waves, the phenomenon of interference, determining the speed of waves in liquids and solids, standing waves (sound sources), the Doppler phenomenon.	4
Cl 12-13	Analyse and solve selected tasks/problems using the first and second principles of thermodynamics. Determine: a) the value of heat exchanged by a thermodynamic system (ideal gas (IG)) with its surroundings, b) the work done by IG, c) changes in internal energy and entropy of IG during quasi-quasi-static transformations (isochoric, isobaric, isothermal, adiabatic), d) coefficients of efficiency of thermal machines operating in the simple and inverse cycle, e) heat transported in the process of thermal conduction.	4
Cl 14-15	Analysing and solving selected problems in electrostatic fields and direct current. In particular, determination of: a) vector (field strength) and scalar characteristics of electrostatic field (potential) using Gauss's law, b) values of electrostatic interaction forces, c) potential energy, d) electric capacitance. Solving tasks involving constant electric current and electrical circuits.	4
	Total hours	30

TEACHING TOOLS USED
N1. Traditional lecture in the form of presentation, supported by demonstrations/demonstrations of physical laws and phenomena. N2. The course work - individual studies and preparation for calculus exercises (coursework). N3. The student presents their own solutions to tasks or problems; discussion on the solutions presented. N4. The student complete 6 written test papers after every two practical classes. N5. The student complete 6 homework assignments per semester. N6. Portfolio - students' own work - students collect in a portfolio documents confirming their personal activities: essays, solutions to assignments, texts of tests with marks, scores in e-tests, notes from lectures, classes, consultations, texts of letters sent (received) via e-mail to (from) the lecturer or academic teachers and other documents. N7. The student consultations with the lecturer and tutor and via e-mail. N8. Students’ own work - individual studies and preparation for the final examination.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 - PEU_W07 PEU_U01 - PEU_U08 PEU_K01 - PEU_K03	Assessment on the basis of oral answers and written tests in Classes, homework, portfolio (written or online)
F2	PEU_W01 - PEU_W07	Written examination (written or online)
P = 0,3*F1 + 0,6*F2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] David Halliday, Robert Resnick, Jearl Walker, Fundamentals of Physics, 10th ed. 2013.
[2] Roger A. Freedman, Hugh D. Young, Solutions for University Physics with Modern Physics 15th (2020) at https://www.numerade.com/books/university-physics-with-modern-physics-15th/
[3] D.C. Giancoli, Physics Principles with Applications, published by Addison-Wesley, various editions (2000-2019); Physics: Principles with Applications with Mastering Physics, 6th edition published by Addison-Wesley (2000-2019).
[4] P. A. Tipler, G. Mosca, Physics for Scientists and Engineers, W. H. Freeman and Company, various editions (2003, 2007)

SECONDARY LITERATURE:

[1] lecture content available to course participants

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr hab. inż. Sebastian Kraszewski (sebastian.kraszewski@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish PODSTAWY CHEMII OGÓLNEJ
Name of subject in English PRINCIPLES OF CHEMISTRY
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15	30			
Number of hours of total student workload (CNPS)	50	50			
Form of crediting	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	Examination-/ crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	2	2			
including number of ECTS points for practical classes (P)		2			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,68	1,28			

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Basic knowledge of chemistry at high school level

SUBJECT OBJECTIVES

C1 Obtaining basic knowledge of the laws governing chemical phenomena, the structure of matter as well as chemical bonds and states of matter
C2 Basic knowledge of the properties of elements and chemical compounds and their molecular structure
C3 Basic chemical calculations skills
C4 Basic knowledge of inorganic compounds, their properties and applications

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 has ordered, theoretically founded general knowledge about the properties of chemical compounds, molecular structure and their application in biomedical engineering

relating to skills:

PEU_U01 can understand the procedure of experiments based on physicochemical techniques. Can characterize, analyze, and identify chemical compounds using measurement techniques.

PEU_U02 is able to perform basic chemical calculations

relating to social competences:

PEU_K01 can think and act creatively.

PEU_K02 is able to cooperate in a group.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Application of chemistry in biomedical engineering.	2
Lec 2	Elements of the structure of matter. Periodic table, chemical elements, the law of periodicity. Electronic structure of an atom and molecules.	2
Lec 3	Chemical bonds. Formal degree of oxidation. Molecular orbitals theory. The theory of valence bonds.	2
Lec 4	Intermolecular interactions.	2
Lec 5	States of matter. Phase transitions. Gaseous state. Gas state equations.	2
Lec 6	Solid state. Ionic and molecular crystals.	2
Lec 7	Liquids. Solutions. Properties of liquids and solutions. Electrolytes. Electrolytic dissociation. Strong and weak electrolytes. Acids and bases. Ampholytes. Hydrolysis.	2
Lec 8	Types of chemical reactions. The rate of chemical reactions. Chemical kinetics. Catalysis. Chemical thermodynamics.	2
	Total hours	15

	Classes	**Number of hours**
Cl 1	Chemical reactions. Redox reactions.	4
Cl 2	Concentrations of solutions	4
Cl 3	Reaction efficiency, conversion of solution concentrations	4
Cl 4	Dissociation of solutions	2
Cl 5	Ionic strength and activity factor	2
Cl 6	pH of the solution	2
Cl 7	Chemical equilibria. Acids and bases, pK	4
Cl 8	Buffer solutions	2
Cl 9	Solubility: salt effect and common ion effect	2
Cl 10	Chemical thermodynamics	2
Cl 11	Final test	2
	Total hours	30

TEACHING TOOLS USED
N1. Lecture – multimedia presentation N2. Consultations N3. Exercises using the traditional method - blackboard and marker pen

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01	Evaluation of test
F2	PEU_W01 PEU_U01 PEU_U02 PEU_K01 PEU_K02	Assessment of the final test
P1 – exam – lecture P2 – classes – final test		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] A. Cotton, G. Wilkinson, P. Gaus, Chemia nieorganiczna, PWN Warszawa 2015.
[2] L. Jones, P. Atkins, P., Chemia ogólna, PWN Warszawa 2020.
[3] A. Bielański, Chemia ogólna i nieorganiczna, PWN Warszawa 2012.
[4] H. Całus, Podstawy obliczeń chemicznych, WNT Warszawa 1987.
[5] Francis A. Carey; Organic Chemistry. McGraw-Hill Higher Education 2019
[6] Robert T. Morrison, Robert N. Boyd; Chemia organiczna, PWN 1998
[7] John McMurry Chemia Organiczna, PWN 2017
[8] Patrick G.: Chemia organiczna, PWN, Warszawa 2008.
[9] Clayden J., Greeves N., Warren C., Wothers P., Chemia organiczna, t.1. WNT, Warszawa 2016.
[10] Kealey D., Haines P.J., Krótkie wykłady. Chemia analityczna. PWN Warszawa 2015

SECONDARY LITERATURE:

[1] Z. Galus (praca zbiorowa), Ćwiczenia rachunkowe z chemii analitycznej", PWN Warszawa, 2004

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr hab. Marta Kopaczyńska (marta.kopaczynska@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish WPROWADZENIE DO PROGRAMOWANIA
Name of subject in English INTRODUCTION TO PROGRAMMING
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		45		
Number of hours of total student workload (CNPS)	50		75		
Form of crediting	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	2		3		
including number of ECTS points for practical classes (P)			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,28		1,88		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

None

SUBJECT OBJECTIVES

C1 Becoming familiar with the fundamentals of computer programming
C2 Gaining basic knowledge on data structures and algorithms

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 acquires practical knowledge of Java programming language.
PEU_W02 knows basic sorting and searching algorithms.

relating to skills:
PEU_U01 can efficiently use IntelliJ IDEA programming environment.
PEU_U02 can test and debug computer code.
PEU_U03 is able to design and implement simple algorithms.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Introduction to Computers, the Internet and Java	2
Lec 2	Types, variables, loops, and conditional statements	2
Lec 3	Arrays	2
Lec 4	Principles of procedural programming	2
Lec 5-6	Introduction to Object-Oriented Programming	4
Lec 7-8	Strings and Regular Expressions	4
Lec 9-10	Debugging and version control system	4
Lec 11	JavaDoc and Build Automation Tools (Maven and Gradle)	2
Lec 12-13	Sorting and searching algorithms	4
Lec 14	Recursion	2
Lec 15	Final test	2
	Total hours	30

Laboratory		**Number of hours**
Lab 1	Basics of Java programming, introduction to IntelliJ IDEA environment	3
Lab 2	Conditional statements	3
Lab 3	Loops (for, while, do-while)	3
Lab 4	Arrays	3
Lab 5	Multidimensional arrays	3
Lab 6	Methods	3
Lab 7-8	Introduction to Object-Oriented Programming	6
Lab 9	Strings	3
Lab 10	Regular Expressions	3
Lab 11	Midterm test	3
Lab 12-13	Sorting and searching algorithms	6
Lab 14	Recursion	3
Lab 15	Final test	3
	Total hours	45

TEACHING TOOLS USED

N1. Traditional lecture
N2. Computer laboratory – solving tasks
N3. Lab reports
N4. Consultations
N5. Self-study
N6. Digital resources (ePortal PWr)
N7. Quizzes

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02	Final test
F2	PEU_U01 PEU_U02 PEU_U03	Lab reports
F3	PEU_U01 PEU_U02 PEU_U03	Quizzes
P = F1 (lecture) P = weighted average of F2 and F3 (laboratory)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Horstmann C., Core Java Volume I--Fundamentals (Core Series) (11th Edition), 2018
[2] Deitel P., Deitel H., Java How to Program, Early Objects (11th Edition), 2017
[3] Downey A.B., Think Data Structures: Algorithms and Information Retrieval in Java, 2017

SECONDARY LITERATURE:

[1] Cutajar J., Beginning Java Data Structures and Algorithms: Sharpen your problem solving skills by learning core computer science concepts in a pain-free manner, 2018
[2] Schildt H., Java: A Beginner's Guide (Eighth Edition), 2018

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr hab. inż. Mirosław Łątka (miroslaw.latka@pwr.edu.pl)
dr inż. Klaudia Kozłowska (klaudia.kozlowska@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish PODSTAWY ELEKTRONIKI MEDYCZNEJ
Name of subject in English INTRODUCTION TO MEDICAL ELECTRONICS
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30				
Number of hours of total student workload (CNPS)	50				
Form of crediting	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination-/ crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	2				
including number of ECTS points for practical classes (P)					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,28				

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

W:

- knowledge of basic physical quantities, concepts and laws relating to electrostatics, direct current flow and magnetic field;
- knowledge of complex numbers and basic operations on them;
- basic knowledge of calculus: extreme values finding of one variable function, the concept of a definite integral;
- basic knowledge of algebra: matrices, determinants, and solving of simultaneous linear algebraic equations

U: The student is able to perform basic operations on complex numbers and basic operations within the scope of calculus.

SUBJECT OBJECTIVES

C1 Acquiring basic knowledge affording possibilities for analysis of simple, linear electrical circuits.
C2 Acquainting students with structures and properties of basic electronic components and circuits.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 Student has the well-ordered, and well theoretically based knowledge including basic problems of electrical circuit analysis.

relating to skills:
PEU_U01 Student is able to incorporate, combine and correctly interpret the information pieces relating to electrical phenomena.
PEU_U02 is able to analyse simple electrical circuits.

relating to social competences:
PEU_K01 Student is able to retrieve information from literature, also in foreign languages.
PEU_K02 Student is able to anticipate many-sided effects of her/his decisions and activities.

PROGRAMME CONTENT

Lecture		Number of hours
Lec 1	Physical quantities characterising electrical circuits (electrical charge, current intensity and density, electrical potential and voltage, power and energy)	2
Lec 2	Components of electrical circuits: resistors, capacitors, inductors, voltage sources, and current sources; the properties of ideal and real components	2
Lec 3	Fundamental relationships between currents and voltages in the direct current circuits: Kirchhoff's current and voltage laws; the superposition theorem	3
Lec 4	Selected methods of analysis of the direct current linear circuits: Thévenin's and Norton's theorems; a mesh-current method	4
Lec 5	Examples of the direct current circuits analysis; a maximum power transfer problem	4
Lec 6	Signals and their parameters (periodic signals, finite energy signals, noise signals; the average and effective value of the signals)	2
Lec 7	A steady-state response of linear circuits with sinusoidal excitation - a symbolic method: reactances and an impedance	2
Lec 8	Examples of analysis: phasors, circuit transmittance and its change with frequency (RC low-pass and high-pass filters), a maximum power transfer problem, resonance	4
Lec 9	Examples of transient state analysis for RC circuits	3
Lec 10	Semiconductor materials, the p-n junction and its characteristics under forward and reverse bias	2
Lec 11	The course completion test	2
	Total hours	30

TEACHING TOOLS USED
N1. Multimedia lecture with elements of a traditional lecture; N2. Numerous numerical examples of circuits' analyses considered during the lectures; N3. Lecture slides available on university ePortal; N4. Data sheets and application notes of the presented components; N5. Individual talks with students; N6. The lecture course completion: a written test.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W03 PEU_U01 PEU_U02 PEU_K01 PEU_K02	A written final test completing the lecture course (colloquium)
P- the mark obtained for the written final test (colloquium)		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Bird J., Electrical and electronic principles and technology, Newnes, Elsevier, 2007 (third edition) – available in the web. [2] Horowitz P., Hill W., The Art of Electronics. Cambridge University Press, New York, USA, 1980, 1989. [available also in Polish as:] Sztuka elektroniki, cz. 1 i 2, WKŁ, Warszawa, 2009. [3] Enderle J.D., Bioinstrumentation. Morgan & Caypool, 2006 [4] Webster J.G., Bioinstrumentation. Ed. Hoboken, John Wiley & Sons, London, 2004 **SECONDARY LITERATURE:** [1] Wolski W., Teoretyczne podstawy techniki analogowej, Oficyna Wydawnicza Politechniki Wrocławskiej, 2007 [2] Bolkowski S., Teoria obwodów elektrycznych, WNT, Warszawa 2007 [3] Rusek A., Pasierbiński J., Elementy i układy elektroniczne w pytaniach i odpowiedziach, WNT, Warszawa 2006
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
dr inż. Grzegorz Smołalski (grzegorz.smolalski@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish ANALIZA MATEMATYCZNA 2.1 A
Name of subject in English MATHEMATICAL ANALYSIS 2.1 A
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30	30			
Number of hours of total student workload (CNPS)	75	75			
Form of crediting	Examination / ~~crediting with grade*~~	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	3	3			
including number of ECTS points for practical classes (P)		3			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,44	1,28			

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.W, U: Student possesses knowledge of analysis I (limits of sequences and functions, calculus, indefinite integral).
2. W, U: Student knows the basic linear algebra.

SUBJECT OBJECTIVES

C1 Learning the structure and properties of a definite integral. Acquiring the ability to use the definite integral for engineering calculations.
C2 Learning the basic concepts of differential and integral calculus of functions of several variables.
C3 Mastering the knowledge of numerical and power series.

C4 Applying acquired knowledge to create and analyse mathematical models for solving theoretical and practical problems in various fields of science and technology.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Student knows the structure of the definite integral and its properties.

PEU_W02 Student knows the basics of differential and integral calculus of functions of several variables.

PEU_W03 Student has basic knowledge of the theory of numerical and power series, knows the criteria of convergence.

relating to skills:

PEU_U01 Student is able to calculate and interpret the definite integral, is able to solve engineering problems using integrals.

PEU_U02 Student is able to calculate partial and directional derivatives and gradient of a function of several variables and interpret the obtained quantities, is able to solve optimization problems for functions of several variables.

PEU_U03 Student is able to calculate and interpret a multiple integral, is able to solve engineering problems with the use of double and triple integrals.

PEU_U04 Student is able to expand functions into a power series, is able to use the obtained series for approximate calculations.

relating to social competences:

PEU_K01 Student is able to search for and use the literature recommended for course and to acquire knowledge independently.

PEU_K02 Student understands the need for systematic and independent work on mastering the course material.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Definite integral. Definition. Geometric and physical interpretation. Newton-Leibnitz Theorem. Integration by parts and by substitution.	2
Lec 2	Properties of the definite integral. The mean value of the function on the interval. Applications of definite integrals in geometry (area, arc length, volume of a revolving solid, lateral surface area of a revolving solid) and in technics.	3
Lec 3	Ordinary differential equations with separated variables and first order linear differential equations.	2
Lec 4	Numerical series. Definition of a numerical series. Partial sums, the remainder of a series. Geometric series. A necessary condition for the series convergence. Convergence criteria for series with non-negatives terms. Absolute and conditional convergence. Leibniz's criterion. Approximate sums of series.	4
Lec 5	Power series. Definition of a power series. Radius and interval of convergence. Cauchy-Hadamard theorem. Taylor and Maclaurin series. Expanding functions into power series.	2
Lec 6	Functions of two and three variables. Subsets of the plane and of the space. Examples of graphs of functions of two variables.	2
Lec 7	Partial derivatives of the first order. Definition. Geometric interpretation. Partial derivatives of higher orders. Schwarz Theorem.	2

Lec 8	The tangent plane to a graph of a function of two variables. Differential of a function and its applications. Partial derivatives of composite functions. Directional derivative. The gradient of a function.	2
Lec 9	Local extrema of functions of two variables. Necessary and sufficient conditions for the existence of an extremum. Conditional extrema of functions of two variables. The smallest and largest value of a function on a set. Examples of extremal problems in geometry and technology.	2
Lec 10	Double integrals. Definition of a double integral. Geometric and physical interpretation. Calculation of double integrals over normal areas.	2
Lec 11	Properties of double integrals. Change of variables in double integrals. Double integral in polar coordinates.	2
Lec 12	Triple integrals. Converting triple integrals into an iterated integral. Converting variables to cylindrical and spherical coordinates.	3
Lec 13	Applications of double and triple integrals in geometry, physics and technology.	2
	Total hours	30

Classes		**Number of hours**
Cl 1	Calculation of definite integrals with the use of methods presented in the lecture. Solving differential equations with separated variables and linear differential equations of the first order. Application of definite integrals for engineering calculations.	5
Cl 2	Calculation of the sum of numerical series. Conditional and absolute convergence. Convergence of a power series. Calculating Maclaurin series. Approximate calculation of series and integrals.	4
Cl 3	Determining the natural domains of functions of several variables and examining their graphs. Calculating limits and examining continuity of a function of several variables.	4
Cl 4	Calculation of partial derivatives. Determining the tangent plane. Estimating quantities with the use of the differential of a function. Calculation of directional derivatives and gradients.	3
C1 5	Determining the extrema of functions of two variables. Determining conditional extrema.	4
	Total hours	30

TEACHING TOOLS USED
N1. Lecture – traditional method N2. Classes – traditional method N3. Student's own work with the use of mathematical packages

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1		Tests, oral answers
F2		Exam
P Exam		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Stewart, J., Calculus: Early Transcendentals (8th Edition), Cengage Learning, 2015

SECONDARY LITERATURE:

[1] Bers, L., Calculus, Holt, Rinehart and Winston, 1969

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

prof. dr hab. Michał Morayne (michal.morayne@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish: FIZYKA 2
Name of subject in English: PHYSICS 2
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st/ ~~2nd level, uniform magister studies~~*, full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional / university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30	15	45		
Number of hours of total student workload (CNPS)	50	25	50		
Form of crediting	Examination / ~~crediting with grade~~*	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	2	1	2		
including number of ECTS points for practical classes (P)		1	2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,44	0,68	1,88		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Successful completion of the Algebra and Analytic Geometry, Mathematical Analysis and Physics 1 courses

SUBJECT OBJECTIVES

C1. Acquisition of basic knowledge, considering application aspects, of the following branches of classical electrodynamics:

C1.1. Magnetostatics
C1.2. Electromagnetic induction
C1.3. Maxwell's equations

C1.4. Electromagnetic waves

C2. Acquisition of basic knowledge, including its application aspects, in the following branches of modern physics:
- C2.1. Special theory of relativity
- C2.2. Elements of quantum physics
- C2.3. Fundamentals of solid-state physics
- C2.4. Elements of nuclear physics
- C2.5 Elementary particles and astrophysics

C3. To learn the basic techniques and methods of measuring selected physical quantities

C4. Acquiring skills:
- C4.1 Plan and carry out experiments in the Physics Fundamentals Laboratory involving the experimental verification of selected laws/physics principles and the measurement of physical quantities
- C4.2 Process measurement results, estimate measurement uncertainties, prepare a written report on the measurements carried out using application software.

C5. To develop and consolidate social competences, including an understanding of the need for continuous learning, and the ability to:
- C.5.1 communicate, critically evaluate undertaken and completed own actions as well as possessed knowledge and skills,
- C5.2 independently plan experiments and carry out measurements using application software,
- C5.3 correctly, independently make decisions and interpret obtained results of measurements, draw conclusions based on possessed knowledge,
- C5.4 cooperate and work in a group.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 has a well-founded knowledge of magnetostatics and the phenomenon of electromagnetic induction and knows examples of applications of the laws of magnetostatics and Faraday's law in physics and engineering practice.

PEU_W02 has a well-founded knowledge of Maxwell's equations, the properties of electromagnetic waves (metamaterials) and applications of this knowledge in physics and engineering practice.

PEU_W03 has a basic knowledge of the special (general) theory of relativity and its applications in relativistic kinematics and dynamics, in particular global positioning systems.

PEU_W04 has knowledge related to the fundamentals of quantum physics, atomic physics, solid state physics and its selected applications in engineering activities.

PEU_W05 has a systematic knowledge of nuclear physics and its applications, has a knowledge of particle physics and astrophysics.

PEU_W06 knows: a) principles of safety and hygiene in force in the Physics Fundamentals Laboratory, b) methods of performing simple and complex measurements of physical quantities, c) methods of preparing measurement results, estimating uncertainty of simple and complex measurements and principles of preparing written reports supported by utility software (text editors, graphics programs).

relating to skills:

PEU_U01 can independently present in writing or orally, correctly and concisely, issues which are the content of the educational objectives PEU_W01-PEU_W05.

PEU_U02 can apply knowledge of magnetostatics and the phenomenon of electromagnetic induction to: a) qualitative and quantitative characterization/explanation of

	selected electromagnetic phenomena, b) solving standard tasks in the field defined by PEU_W01.
PEU_U03	can: a) explain concisely and correctly the physical sense of the system of Maxwell's equations, characterize the physical properties of electromagnetic waves, metamaterials and their applications, b) solve standard tasks in the field and use the knowledge of PEU_W02.
PEU_U04	can: a) apply knowledge concerning special and general relativity theory to interpret selected relativistic effects and phenomena, b) justify the necessity of implementation of the consequences of special relativity theory in the global positioning systems (GPS), c) solve standard tasks within the scope of knowledge specified PEU_W03.
PEU_U05	has the ability to apply knowledge of contemporary physics (quantum physics, atomic physics, solid state physics) to: a) qualitative and quantitative interpretation of selected phenomena and effects of physics of atoms and FCS, which occur at the microscopic and nanoscopic distance scales, b) explain physical principles of operation of selected semiconductor devices, c) solve standard tasks in the field of knowledge PEU_W04.
PEU_U06	can: a) characterize and present briefly the basic phenomena and laws of nuclear physics, b) present a standard model of elementary particles, c) characterize types of matter in the Universe and present and justify a model of the expanding Universe, d) solve standard tasks in the field and use the knowledge of PEU_W05.
PEU_U07	can: a) perform simple complex measurements of physical quantities, using adequate instruments and methods, observing the principles of work safety, b) process measurement results, perform the analysis of measurement uncertainty and prepare a report on measurements performed in the Physics Fundamentals Laboratory using PEU_W06 knowledge and the appropriate application software.
relating to social competences:	
PEU_K01	understands the need for lifelong learning and for improving knowledge/acquisition skills and communication methods.
PEU_K02	is able to independently plan experiments and carry out measurements using application software and prepare a concise, factually correct report of the measurements made.
PEU_K03	is able to interpret the results of measurements, i.e., draw conclusions on the basis of its knowledge.
PEU_K04	can interact and work in a group.

PROGRAMME CONTENT		
Lecture		**Number of hours**
Lec 1-2	Organizational matters. Methods of vector field analysis. Magnetostatics	4
Lec 3-4	Electromagnetic induction and Maxwell's equations	4
Lec 5-6	Electromagnetic waves	4
Lec 7-8	Special principle of relativity	3
Lec 8-12	Selected topics in quantum physics	9
Lec 13	Selected topics in solid state physics	2

Lec 14	Selected topics in nuclear physics	2
Lec 15	Selected topics in particle physics and astrophysics	2
	Total hours	30

Classes		Number of hours
Cl 1	Organizational matters. Presentation of the correctness of calculation task solving	1
Cl 2	Coulomb's law. Application of the field superposition principle. Dipole in an electric field	2
Cl 3	Solving problems on the application of Gauss's law. Electric field potential. Capacitors. Movement of electric charge in an electric field	2
Cl 4	Magnetic field. Motion of a charge in a magnetic field	2
Cl 5	De Broglie waves. Schrödinger equation. Dirac notation. Hilbert space	2
Cl 6	Motion in a field with spherical symmetry (hydrogen atom). Mean values of operators. Composition of angular momentum. Principle of indeterminacy	2
Cl 7	Unbound states - dissipation. Time-independent disturbances. Time-dependent Hamiltonian	2
Cl 8	Colloquium - verification of problem-solving skills	2
	Total hours	15

Laboratory		Number of hours
Lab 1	Introduction to LPF - matters of course organization. To introduce students: a) to the principles of safe measurement (short training in occupational safety and health) and the LPF regulations, b) to the principles of written preparation of a report/report, c) to the basics of measurement uncertainty analysis, d) to the necessity to have a portfolio at each class, where the student gathers documents confirming his/her personal activity, achievements, cards with marks, prepared reports or essays, notes from laboratory classes, lectures or consultations, etc. Students acquire practical skills in making simple measurements of physical quantities.	3
Lab 2	Students carry out measurements on an electrical circuit using analogue and digital meters, statistically process the obtained results of simple and complex measurements, estimate the uncertainty values of the experimentally obtained measurement results, present the results of their own measurements on graphs and prepare, for the first time individually, a written report.	3
Lab 3-4	Two-person student teams carry out measurements of selected mechanical quantities and prepare a written report containing: a) a brief description of the measurement site and main objectives of the measurements, b) results of measurements, accuracy of used meters, results of calculated/determined, based on the results of measurements, values of physical quantities, etc. (results of measurements, data and values of determined physical quantities are included in tables), c) graphical representations (if required) of the measured values. (c) the evaluation of the measurement uncertainty of the measured physical quantities, (d) graphical representations (if required) of the measurement results with the measurement uncertainty values plotted on graphs, (e) conclusions and closing remarks.	6
Lab 5-6	Two-person student teams take measurements of selected thermodynamic quantities and prepare written reports containing the elements listed in the description of the Lab 3-4.	6

Lab 7	Review of student reports on completed laboratory exercises in lab.2-5 by the academic teacher in charge of the course, who generally assesses the students' skills on the prepared reports, presents and discusses irregularities and errors noticed in the reports, and gives advice to student groups or individual students.	3
Lab 8-9	Two-person student teams perform measurements of selected electromagnetic quantities and prepare written reports containing the elements listed in the description of the Lab 3-4.	6
Lab 10-11	Student teams of two take measurements of selected optical quantities and produce written reports containing the elements listed in the description of the Lab 3-4.	6
Lab 12-13	Two-person student teams make measurements of selected quantum quantities produce written reports containing the elements listed in the description of the Lab 3-4.	6
Lab 14	Complementary classes	3
Lab 15	Supplementary classes and credits	3
	Total hours	45

TEACHING TOOLS USED
N1. Traditional lecture in the form of presentation, supported by demonstrations/demonstrations of physical laws and phenomena. N2. The course work - individual studies and preparation for preparation for classes in LPF. N3. Laboratory exercises - groups of two students take measurements of simple and complex physical quantities. N4. Laboratory exercises - short written tests, so-called entrance tests. N5. Portfolio - students' own work - students collect in a portfolio documents confirming their personal activities: essays, solutions to assignments, texts of tests with marks, scores in e-tests, notes from lectures, laboratories, consultations, texts of letters sent (received) via e-mail to (from) the lecturer or academic teachers and other documents. N6. The student consultations with the lecturer and tutor and via e-mail. N7. Students’ own work - individual studies and preparation for the final examination.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 - PEU_W06 PEU_U01 - PEU_U07 PEU_K01 - PEU_K04	Assessments of: a) tests, b) oral answers to questions asked by the academic teacher, c) manner of performing measurements, d) reports, e) content and quality of documents collected in the portfolio
F2	PEU_W01 - PEU_W06	Written examination (written or online)
P = 0,3*F1 + 0,6*F2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] David Halliday, Robert Resnick, Jearl Walker, Fundamentals of Physics, 10th ed. 2013.
[2] Roger A. Freedman, Hugh D. Young, Solutions for University Physics with Modern Physics 15th (2020) at https://www.numerade.com/books/university-physics-with-modern-physics-15th/
[3] D.C. Giancoli, Physics Principles with Applications, published by Addison-Wesley, various editions (2000-2019); Physics: Principles with Applications with Mastering Physics, 6th edition published by Addison-Wesley (2000-2019).
[4] P. A. Tipler, G. Mosca, Physics for Scientists and Engineers, W. H. Freeman and Company, various editions (2003, 2007)

SECONDARY LITERATURE:

[1] lecture content available to course participants
[2] instructions for laboratory activities

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr hab. inż. Sebastian Kraszewski (sebastian.kraszewski@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish PODSTAWY CHEMII ORGANICZNEJ
Name of subject in English PRINCIPLES OF ORGANIC CHEMISTRY
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30				
Number of hours of total student workload (CNPS)	50				
Form of crediting	~~Examination~~ / crediting with grade*	Examination-/ crediting with grade*	Examination-/ crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	2				
including number of ECTS points for practical classes (P)					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,28				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Basic knowledge of chemistry at high school level

SUBJECT OBJECTIVES

C1 Basic knowledge of organic chemistry
C2 Basic knowledge of organic compounds, their properties, applications and functions in the body
C3 Identification of chemical compounds

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 has a basic knowledge of organic chemistry, about the structure of organic compounds, their properties, applications and functions in the body.

PROGRAMME CONTENT		
Lecture		**Number of hours**
Lec 1	Organic Chemistry in Biomedical Engineering	2
Lec 2	Structure of organic compounds. Classification of organic compounds.	2
Lec 3	Isomerism of organic compounds - structural, conformational, geometric and optical. Stereochemistry.	2
Lec 4-5	Transformations of organic compounds. Types of organic reactions and types of mechanisms. Mechanisms of basic types of organic reactions. Elements of organic synthesis.	4
Lec 6	Hydrocarbons. Aromatic hydrocarbons - benzene derivatives.	2
Lec 7	Alcohols and phenols.	2
Lec 8	Ethers and Oxiranes.	2
Lec 9	Aldehydes and Ketones	2
Lec 10	Carboxylic acids and their derivatives.	2
Lec 11	Fatty acids. Lipids.	2
Lec 12	Organic nitrogen compounds: nitro compounds, amines, azo and diazo compounds, isocyanates, amino acids, peptides, proteins.	2
Lec 13	Macromolecules. Polymers. Sugars.	2
Lec 14	Physicochemical measurement techniques for the analysis and identification of organic compounds.	2
Lec 15	Exam	2
	Total hours	30
TEACHING TOOLS USED		
N1. Lecture – multimedia presentation		

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01	Evaluation of exam
P1 – exam – lecture		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Francis A. Carey; Organic Chemistry. McGraw-Hill Higher Education 2019
[2] Robert T. Morrison, Robert N. Boyd; Chemia organiczna, PWN 1998
[3] John McMurry Chemia Organiczna, PWN 2017
[4] Patrick G.: Chemia organiczna, PWN, Warszawa 2008.
[5] Clayden J., Greeves N., Warren C., Wothers P., Chemia organiczna, t.1. WNT, Warszawa 2016

SECONDARY LITERATURE:

[1] Articles from journals on the Philadelphia List

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr hab. Marta Kopaczyńska (marta.kopaczynska@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish ELEKTRONIKA MEDYCZNA 2
Name of subject in English MEDICAL ELECTRONICS 2
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30	15	30		
Number of hours of total student workload (CNPS)	50	25	50		
Form of crediting	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	2	1	2		
including number of ECTS points for practical classes (P)		1	2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,28	0,68	1,28		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

W:

- Completion of the courses:
- Introduction to Medical Electronics 1
- Algebra and Analytic Geometry
- Mathematical Analysis 1

U: The student is able to perform basic operations on complex numbers and basic operations within the scope of calculus.

SUBJECT OBJECTIVES

At the end of the course's student should:
C1 be acquainted with the structure, the action, and properties of basic electronic components, and circuits
C2 have practical skills within the scope of analysis of simple linear electrical circuits
C3 know how basic electric quantities may be measured
C4 know how the uncertainty of measurement result should be determined both in a direct and in a combined measurement.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 Student has the well-ordered, and well theoretically based knowledge including the structure, action, and properties of basic analog, and digital electronic components and circuits.

relating to skills:
PEU_U01 Student knows fundamental methods of electrical circuits' analysis and is able to use them in practice in understanding the action of simple electronic circuits.
PEU_U02 Student is able to plan and practically perform simple experiments in which properties of electrical circuits are investigated and is able both to elaborate and to understand the results.

relating to social competences:
PEU_K01 Student is able to retrieve information from literature, also in foreign languages.
PEU_K02 Student is able to anticipate many-sided effects of her/his decisions and activities.

PROGRAMME CONTENT

	Lecture	Number of hours
Lec 1	Diodes: their parameters and examples of application	2
Lec 2	Transistors: operation of the selected kinds of them; biasing rules; transistor parameters, characteristic curves and examples of application	2
Lec 3	Amplifiers: their parameters and selected applications	2
Lec 4	Operational amplifier and basic circuits of its application	2
Lec 5	Instrumentation amplifier	2
Lec 6	Filters and their trasmitance functions	2
Lec 7	Switches	2
Lec 8	Digital circuits: physical implementation of logic states, logic gates and their parameters, families of logic, driving bus lines	2
Lec 9	Examples of combinational networks	2
Lec 10	Examples of sequential logic: flip-flops, registers, counters, shift registers, memories and the types of them	2
Lec 11	Measurement science: Measurement process	2
Lec 12	Measurement science: Measurement instrumentation	2
Lec 13	Measurement science: Measurement technique	2
Lec 14	Measurement science: Measurement error and uncertainity	2
Lec 15	The course completing tests	2
	Total hours	30

Classes		Number of hours
Cl 1	DC electrical circuit analysis (series and parallel resistive circuits, Kierchhoff's laws)	2
Cl 2	DC electrical circuit analysis (Thévenin's and Norton's theorems; a mesh-current method)	2
Cl 3	Signals and their parameters	2
Cl 4	AC electrical circuit analysis (impedance, series and parallel RLC circuits)	2
Cl 5	AC electrical circuit analysis (equivalent circuits of the two-terminal RLC networks)	2
Cl 6	AC electrical circuit analysis (AC power, resonance)	2
Cl 7	Measurement error and uncertainity	2
C1 8	Measurement error and uncertainity	1
	Total hours	15

Laboratory		Number of hours
Lab 1	Introduction	2
Lab 2	Measurement of DC voltages and currents, the multimeter	2
Lab 3	Basic laws of electricity	2
Lab 4	Linear and non-linear passive electrical components	2
Lab 5	DC voltage and current sources	2
Lab 6	The generator and oscilloscope: signals and observation of their shapes	2
Lab 7	Measurements of AC signal parameters	2
Lab 8	Time period and frequency measurement	2
Lab 9	Passive filters and their frequency characteristics	2
Lab 10	Operational amplifier	2
Lab 11	Digital networks	2
Lab 12	Measurement of RLC elements parameters	2
Lab 13	Logic gates	2
Lab 14	Flip flops and digital counters	2
Lab 15	Students' individual repetition and course completion	2
	Total hours	30

TEACHING TOOLS USED

N1. Multimedia lecture with elements of a traditional lecture
N2. Numerous numerical examples of circuits' analyses considered during the lectures and classes
N3. Lecture slides available on university ePortal
N4. Data sheets and application notes of the presented components
N5. Individual talks with students
N6. Written tests completing the lecture and classes courses
N7. Practical experiments performed during the laboratory course, and elaborating the reports of them

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_U01	A written colloquium completing a lecture course
F2	PEU_U01 PEU_U02 PEU_K01	Multiple numerical examples solved during the lectures A short written tests during the classes Lists of symbolic and numerical tasks set as homework and then solved during classes on the blackboard
F3	PEU_U02 PEU_K02	Written reports completing every laboratory topic

P – Lecture: a pass mark received during the completing colloquium
P – Classes: completing all the tests and the marks received for solving the ordered problems on the blackboard
P – Laboratory: completing all the tests and the marks received for performing laboratory tasks and for the reports completing laboratory topics.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Bird J., Electrical and electronic principles and technology, Newnes, Elsevier, 2007 (third edition) – available in the web.
[2] Horowitz P., Hill W., The Art of Electronics. Cambridge University Press, New York, USA, 1980, 1989. [available also in Polish as:] Sztuka elektroniki, cz. 1 i 2, WKŁ, Warszawa, 2009.
[3] Enderle J.D., Bioinstrumentation. Morgan & Caypool, 2006
[4] Webster J.G., Bioinstrumentation. Ed. Hoboken, John Wiley & Sons, London, 2004
[5] Data sheets and application notes of the presented components
[6] Kirkup L., Frenkel B., An introduction to Uncertainty in Measurement using the gum. Cambrige University Press, 2006
[7] Hebra A.J., The Physics of Metrology: All about Instruments: From Trundle Wheels to Atomic Clocks, SpringerWienNewYork, 2010

SECONDARY LITERATURE:

[1] Wolski W., Teoretyczne podstawy techniki analogowej, Oficyna Wydawnicza Politechniki Wrocławskiej, 2007
[2] Bolkowski S., Teoria obwodów elektrycznych, WNT, Warszawa 2007
[3] Rusek A., Pasierbiński J., Elementy i układy elektroniczne w pytaniach i odpowiedziach, WNT, Warszawa 2006

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
dr inż. Grzegorz Smołalski (grzegorz.smolalski@pwr.edu.pl) dr inż. Wioletta Nowak (wioletta.nowak@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish WPROWADZENIE DO PROGRAMOWANIA OBIEKTOWEGO
Name of subject in English INTRODUCTION TO OBJECT-ORIENTED PROGRAMMING
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		60		
Number of hours of total student workload (CNPS)	75		75		
Form of crediting	Examination / ~~crediting with grade~~*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	3		3		
including number of ECTS points for practical classes (P)			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,44		2,48		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

It is required to pass the following course: Introduction to Programming.

SUBJECT OBJECTIVES

C1 Becoming familiar with fundamental concepts of object-oriented programming

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 knows object-oriented programming paradigm.

relating to skills:
PEU_U01 can define class hierarchies.
PEU_U02 can perform unit tests.
PEU_U03 can develop JavaFX desktop applications.

relating to social competences:
PEU_K01 knows the principles of collaborative coding.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Inheritance and polymorphism	2
Lec 2	Interfaces	2
Lec 3-4	Exceptions	4
Lec 5	Unit tests	2
Lec 6-7	JavaFX	4
Lec 8-9	Generic collections	4
Lec 10	Lambdas and Streams	2
Lec 11	Generic Classes and Methods	2
Lec 12	Custom Generic Data Structures	2
Lec 13-14	Design patterns	4
Lec 15	Final test	2
	Total hours	30

Laboratory		**Number of hours**
Lab 1	Fundamentals of object-oriented programming	4
Lab 2	Inheritance	4
Lab 3	Abstract classes and interfaces	4
Lab 4	JSON (JavaScript Object Notation)	4
Lab 5	Unit tests	4
Lab 6	Midterm test	2
Lab 7	JavaFX part I	6
Lab 8	JavaFX part II	6
Lab 9	Generic collections	6
Lab 10	Lambdas and Streams	4
Lab 11	Generic Classes and Methods	4
Lab 12	Custom Generic Data Structures	4
Lab 13-14	Design patterns	6
Lab 15	Final test	2
	Total hours	60

TEACHING TOOLS USED
N1. Traditional lecture N2. Computer laboratory – solving tasks N3. Lab reports N4. Consultations N5. Self-study N6. Digital resources (ePortal PWr) N7. Quizzes

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01	Final test
F2	PEU_U01 PEU_U02 PEU_U03 PEU_K01	Lab reports
F3	PEU_U01 PEU_U02 PEU_U03	Quizzes
P = F1 (lecture) P = weighted average of F2 and F3 (laboratory)		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Deitel P., Deitel H., Java How to Program, Early Objects (11th Edition), 2017 [2] Schildt H., Java: A Beginner's Guide (Eighth Edition), 2018 **SECONDARY LITERATURE:** [1] Evans B.J., Flanagan D., Java in a Nutshell: A Desktop Quick Reference (6th Edition), 2014 [2] Horstmann C., Core Java SE 9 for the Impatient, 2017
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
dr hab. inż. Mirosław Łątka (miroslaw.latka@pwr.edu.pl) dr inż. Klaudia Kozłowska (klaudia.kozlowska@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish PROPEDEUTYKA NAUK MEDYCZNYCH
Name of subject in English PROPAEDEUTICS OF MEDICAL SCIENCES
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30				
Number of hours of total student workload (CNPS)	50				
Form of crediting	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	2				
including number of ECTS points for practical classes (P)					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,28				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Anatomy for Biomedical Engineers

SUBJECT OBJECTIVES

C1 Acquiring knowledge about the basic conceptual categories related to propaedeutics of medical sciences.
C2 Acquiring basic knowledge about the pathology of organs and systems of the human body, epidemiology, civilization diseases, infectious diseases, immunology, transplantology, cancer.
C3 Acquiring basic knowledge of the use of Biomedical Engineering methods in therapy, diagnostics, and health care.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 knows and understands the basic concepts of propaedeutics of medical sciences.

PEU_W02 has extended knowledge of diseases and pathologies of organs.

PEU_W03 has ordered general knowledge, covering issues related to the structure of the human body at the cellular, tissue and organ levels.

PEU_W04 has knowledge of the use of biomedical engineering methods in therapy, diagnostics and health care.

relating to skills:

PEU_U01 is able to obtain information from literature, databases and other sources, is able to correctly interpret, select and combine the obtained information, is able to apply the obtained information in practice, in particular, is able to prepare a paper on a given topic concerning the use of biomedical engineering methods in combating diseases and pathologies.

PEU_U02 is able to draw conclusions, formulate and justify opinions, in particular in the field of knowledge of the propaedeutics of medical sciences.

relating to social competences:

PEU_K01 can interact and cooperate in a group, taking various roles in it, is ready to think and act in an entrepreneurial way.

PEK_K02 is aware of the social and professional role of a technical university student, especially in the field of reliable and honest transfer of information, and fair process of checking knowledge.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Introduction. Basic terminology of propedeutics of medical sciences, introduction to medicine based on prediction, prevention and personalized approach to the patient.	1
Lec 2	Diseases – introduction; basic definitions, course, symptoms Fundamentals of epidemiology	1
Lec 3	Civilization related diseases. Role of biomedical engineering in therapy and diagnostics.	1
Lec 4	Diabetes mellitus, types of, role of biomedical engineering in therapy, diagnostics and rehabilitation	3
Lec 5	Diseases transmitted by viruses. About HIV and AIDS. COVID19. Fundamentals of vaccinology.	3
Lec 6	Introduction to oncology. Role of biomedical engineering in therapy and diagnostics.	3
Lec 7	Problems of transplantology. Fundamentals of immunology.	3
Lec 8	Heart disorders, the role of biomedical engineering in therapy, diagnostics and rehabilitation.	3
Lec 9	Vascular and cardiovascular disorders, the role of biomedical engineering in therapy, diagnostics and rehabilitation.	3
Lec 10	Diseases of the digestive system, the role of biomedical engineering in the therapy, diagnosis and rehabilitation of diseases of the esophagus and stomach	3

Lec 11	Diseases of the digestive system, the role of biomedical engineering in the therapy, diagnosis and rehabilitation of intestinal diseases.	2
Lec 12	Diseases of the digestive system, the role of biomedical engineering in the therapy, diagnosis and rehabilitation of liver and pancreatic diseases.	2
Lec 13	Kidney diseases, dialysis - the role of biomedical engineering in therapy, diagnostics and rehabilitation	2
	Total hours	30

TEACHING TOOLS USED
N1. Multimedia lectures N2. Tests of knowledge N3. Webinars N4. Individual consultations

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02 PEU_W03 PEU_W04	Multiple Online tests
F2	PEU_U01 PEU_U02 PEU_K01 PEU_K02	Data bases search Participation in webinar Independent preparation as a group work of a presentation on a given topic related the modern diagnosis and treatments exploiting biomedical engineering methods. Online test
P – lecture – final grade is the average of multiple tests performed during the semester. Elaboration of an essay based on the most recent papers published in a relevant scientific journal, is required.		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Any text book on propaedeutics of medical sciences. E.g. V. K. Vasilenko, V. V.Vasilenko, Propaedeutics of internal diseases, ISBN 978-601-240-933-8, 2017 or I. Damjanov Pathophysiology E-Book, Saunders Elsevier, 2009 2009**SECONDARY LITERATURE:** [1] Databases e.g., Medline, PubMed, professional medical websites etc.
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
prof. dr hab. inż. lek. med. Halina Podbielska (halina.podbielska@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish WSTĘP DO OPTYKI I BIOFOTONIKI
Name of subject in English INTRODUCTION TO OPTICS AND BIOPHOTONICS
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		15		15
Number of hours of total student workload (CNPS)	50		25		25
Form of crediting	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	2		1		1
including number of ECTS points for practical classes (P)			1		1
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,28		0,68		0,68

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

First Semester Physics course (lecture and classes)

SUBJECT OBJECTIVES

C1 Obtaining knowledge of fundamentals of Engineering Optics and Biophotonics, and diagnostic devices based on optical phenomena.
C2 Acquiring basic knowledge in respect to the analysis of the observed phenomena of light-tissue interactions and their medical applications.
C3 Solving basic technical and design problems during the implementation of tasks in the laboratory.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 has theoretical general knowledge of Biophotonics fundamentals, including optical parameters of tissues, interaction of light with tissues, optical diagnostics techniques and light based therapeutics approaches.

PEU_W02 has ordered general knowledge of the basics of Optics, knows optical elements, basic instrumentation and rules of working with optical radiation.

relating to skills:

PEU_U01 is able to use the acquired knowledge to formulate and solve complex problems in Biophotonics and Optics.

PEU_U02 can perform laboratory tasks through selection and application of proper methods and tools.

PEU_U03 can plan and carry out experiments including measurements and computer simulations, interpret the obtained results and draw conclusions in the field of Optics and Biophotonics.

PEU_U04 can take part in a debate and present, and evaluate various opinions and positions related to Biophotonics and Optics issues.

PEU_U05 can plan and organize work individually and in a team.

relating to social competences:

PEU_K01 can interact and cooperate in a group, taking various roles in it, is ready to think and act in an entrepreneurial way.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Introduction to the subject and course requirements. Presentation of the conditions for passing the course. Introduction to Engineering Optics and basic optical laws: the law of rectilinear propagation (transmission), the law of reflection, the law of refraction (Snell's law). Concept of refractive index.	3
Lec 2	Electromagnetic radiation. Vision optics. The safety of working with nonionizing radiation – UV, VIS and IR.	3
Lec 3	Fundamentals of geometrical Optics – thin and thick lenses, special lenses	3
Lec 4	Fundamentals of geometrical Optics – prisms and special prisms, plane parallel plates, mirrors	
Lec 5	Fundamentals of optical instrumentation: optical microscopes, collimators, telescopes	3
Lec 6	Introduction to Biophotonics. Waves and Photons. Basic definitions of Biophotonics. Medical applications of optical waves: instrumentation, medical diagnosis.	3
Lec 7	Optical parameters of tissues. Absorption laws and its application in biology and medicine.	3
Lec 8	Luminescence and its biomedical applications in diagnosis and therapy.	3
Lec 9	Thermal interactions of light with tissues and its diagnostic and therapeutic applications.	3

Lec 10	Light scattering and biomedical diagnostic application.	3
	Total hours	30

Laboratory		**Number of hours**
Lab 1	Introduction to the subject and course requirements. Spectroscopic measurements.	2
Lab 1	Optical glasses, safety glasses	2
Lab 2	Interstitial laser thermotherapy – computer simulations	2
Lab 3	Photometric measurements.	2
Lab 4	Microscopic examinations	2
Lab 5	Computer assisted fluorescence images processing	2
Lab 6	Transillumination methods	2
Lab 7	Final test	1
	Total hours	15
Seminar		**Number of hours**
Semin 1	Introduction to the subject and course requirements.	1
Semin 2	Electromagnetic waves, interaction of radiation with matter, photodynamic medicine, spectroscopy, optogenetics	2
Semin 3	Sources and detectors of radiation, biomedical research techniques using scattering, absorption and interference of light	2
Semin 4	Optical fibers, lasers, diodes, fiber optic sensors	2
Semin 5	Microscopic measurements	2
Semin 6	Transillumination, optical manipulators, thermovision, photoacoustics	2
Semin 7	Endoscopy, holography, vision optics, dermatoscopy	2
Semin 8	Final test	2
	Total hours	15

TEACHING TOOLS USED
N1. Multimedia lectures N2. Multimedia seminars N3. Tests of knowledge N4. Teaching kits for laboratory classes N5. Individual consultations

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENTS

Evaluation (F – forming during semester), P – concluding (at the semester end)	Learning outcomes code	Way of evaluating learning outcomes achievements
F1	PEU_W01 PEU_W02	1. Online tests
F2	PEU_U01 PEU_U02 PEU_U03	1. Performing tasks during the laboratory work 2. Laboratory reports 3. Short tests

	PEU_U05 PEU_K01	
F3	PEU_W01 PEU_W02 PEU_U01 PEU_U04 PEU_U05 PEU_K01	1. Oral presentation 2. Final test

P – lecture – final grade is the average of multiple tests performed during the semester. The part of lectures devoted to Biophotonics requires elaborations of essays based on the most recent biophotonics paper published in a relevant scientific journal and biophotonics webinar.
P – laboratory – average grade of the reports and tests (all grades must be positive).
P – seminar – weighted average grade of the presentation (weight 1/3) and the final test (weight 2/3).

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] S. H. Schwartz, Geometrical and Visual Optics, McGraw-Hill, 3rd edtion, 2019
[2] S. Konijnenberg, A. J. L. Adam, H. P. Urbacc, BSc Optics, Delft University of Technology, 2021, https://textbooks.open.tudelft.nl/textbooks/catalog/book/42
[3] M. Jurgens, T. Mayerhofer, J. Popp, Introduction to Biophotonics, Handbook of Biophotonics, http://onlinelibrary.wiley.com/doi/10.1002/9783527643981.bphot001/pdf
[4] E. Hecht, Optics, Person, 5th edition, 2015
[5] E. Hecht, Solutions for Optics 5th, https://www.numerade.com/books/optics-5th/

SECONDARY LITERATURE:

[1] F.L. Pedrotti, L. M. Pedrotti, L. S. Pedrotti, Introduction to Optics, Cambridge University Press, 3rd edition, 2017
[2] Solutions for Introduction to Optics 3rd, Frank L. Pedrotti, Leno M. Pedrotti, Leno S. Pedrotti, https://www.numerade.com/books/introduction-to-optics-3rd/
[3] http://onlinelibrary.wiley.com/doi/10.1002/9783527643981.bphot001/pdf
[4] http://www.bioopticsworld.com
[5] http://www.biophotonik.org/joomla/images/download/icob-2roadmap.pdf
[6] http://www.photonics.com
[7] relevant journals: Biomedical Optics, Biomedical Optics Express

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

prof. dr hab. inż. lek. med. Halina Podbielska (halina.podbielska@pwr.edu.pl)
dr inż. Joanna Bauer-Matuła (joanna.bauer@pwr.wroc.pl)
dr inż. Katarzyna Wysocka-Król (katarzyna.wysocka@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish BAZY DANYCH
Name of subject in English DATABASES
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30	45	
Number of hours of total student workload (CNPS)	75		75	100	
Form of crediting	Examination / ~~crediting with grade~~*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	3		3	4	
including number of ECTS points for practical classes (P)			3	4	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,44		1,28	1,88	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

It is required to pass the following course: Introduction to Object-Oriented Programming.

SUBJECT OBJECTIVES

C1 Becoming familiar with fundamental concepts of database systems
C2 Gaining basic knowledge on programming and administration of databases
C3 Becoming familiar with database data modelling
C4 Becoming familiar with medical database systems design
C5 Gaining basic knowledge on database documentation

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 knows basic database terminology.
PEU_W02 knows SQL syntax and can write SQL queries.
PEU_W03 acquires knowledge of database project preparation.
PEU_W04 acquires knowledge of data modelling.

Relating to skills:
PEU_U01 is able to employ SQL to retrieve, search, update data and to create database objects.
PEU_U02 is able to implement functions, stored procedures and trigger using SQL.
PEU_U03 is able to make use of data modelling software and to develop simple database application.
PEU_U04 is able to model data, design and normalize database schemes.
PEU_U05 is able to implement database application.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Fundamental concepts of databases. Database architectures	2
Lec 2	Relational data model, functional relationships, keys, referential integrity	2
Lec 3	Data model, verification of the data model, database normalization, entity-relationship diagrams	2
Lec 4	Database design	2
Lec 5-8	SQL (simple queries, joins, subqueries, aggregate and group functions, tables, views, functions, stored procedures, triggers)	8
Lec 9	Transactions	2
Lec 10	Database access control and security	2
Lec 11-12	Java and Object-Relational Mapping with Hibernate	4
Lec 13	NoSQL databases	2
Lec 14	Medical databases, electronic health record	2
Lec 15	Final test	2
	Total hours	30

Laboratory		**Number of hours**
Lab 1	MySQL server and workbench	2
Lab 2	Data modelling	2
Lab 3-4	Database scheme design	4
Lab 5-6	SQL: Data Manipulation Language	4
Lab 7-8	SQL: Data Definition Language	4
Lab 9	SQL: Data access control	2
Lab 10	Database Management System	2
Lab 11	JDBC	2
Lab 12	Object-Relational Mapping with Hibernate	2

Lab 13-15	NoSQL databases	6
	Total hours	30
Project		**Number of hours**
Proj 1-6	Project 1 (SQL)	18
Proj 7	Project Presentation	3
Proj 8-14	Project 2 (NoSQL)	21
Proj 15	Project Presentation	3
	Total hours	45

TEACHING TOOLS USED

N1. Traditional lecture
N2. Computer laboratory – solving tasks
N3. Lab reports
N4. Consultations
N5. Self-study
N6. Digital resources (ePortal PWr)
N7. Quizzes

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02 PEU_W03 PEU_W04	Final test
F2	PEU_U01 PEU_U02 PEU_U03 PEU_U04	Lab reports
F3	PEU_U01 PEU_U02 PEU_U03 PEU_U04	Quizzes
F4	PEU_U01 PEU_U02 PEU_U03 PEU_U04 PEU_U05	Project 1
F5	PEU_U01 PEU_U02	Project 2

	PEU_U03 PEU_U04 PEU_U05	

P = F1 (final test on lecture)
P = weighted average of F2 and F3 (laboratory)
P = weighted average of F4 and F5 (project)

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Elmasri R., Navathe S.B., Fundamentals of Database Systems (7th Edition), 2016
[2] DuBois P., MySQL (5th Edition), 2013
[3] MySQL Documentation (https://dev.mysql.com/doc/)
[4] Harrison G., Next Generation Databases: NoSQL and Big Data, 2015

SECONDARY LITERATURE:

[1] Beighley, L., Head First SQL: Your Brain on SQL – A Learner, 2007
[2] Nyczaj K., Wasilewski, D., „Elektroniczna dokumentacja medyczna po zmianach - z uwzględnieniem regulacji o ochronie danych osobowych (RODO)", 2018
[3] Hernandez M.J., Database Design for Mere Mortals: A Hands-On Guide to Relational Database Design (3rd Edition), 2013

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr inż. Klaudia Kozłowska (klaudia.kozlowska@pwr.edu.pl)

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish MIKROKONTROLERY
Name of subject in English MICROCONTROLLERS
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		45		
Number of hours of total student workload (CNPS)	30		50		
Form of crediting	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	1		2		
including number of ECTS points for practical classes (P)			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,68		1,88		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of digital electronic circuits (logical gates, flip-flops, registers, multiplexers, counters), e.g., Introduction to Medical Electronics 1Introduction to Medical Electronics 2.
2. Basic knowledge of and basic skills in C programming language, e.g., Introduction to Programming.

SUBJECT OBJECTIVES

C1 Acquiring of basic knowledge about the resources of typical microcontroller and about possibilities of their practical application.
C2 Possessing of basic practical skills in programming with an assembler language and skills development at programming techniques in C language.
C3 Practical skills in using of an exemplary development environment for preparing and debugging programs.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 knows the structure of a typical microcontroller and of its peripheral elements and also of its programming in both an assembler and C languages.

PEU_W02 knows basic rules of preparing a proper documentation of a program.

relating to skills:

PEU_U01 is able to analyse, write and practically debug simple programs using typical algorithms and data structures.

PEU_U02 is able to divide a complex programming task into parts and practically build a structured multilevel program

PEU_U03 is able to use basic tool programs such as: editor, assembler, debugger or simulator.

relating to social competences:

PEU_K01 is able to retrieve information from literature, also in foreign languages.

PEU_K02 is able to anticipate many-sided effects of her/his decisions and activities.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Microcontroller as a programmable digital circuit and the programming structure of AVR microprocessor	2
Lec 2	Data transfer instructions – addressing modes.	2
Lec 3	Some typical applications of the logical and arithmetical instructions	1
Lec 4	Building of typical programming structures	2
Lec 5	Division of the program task into blocks – subroutines and a stack. Techniques of parameters' transfer to subroutines	3
Lec 6	Input/Output parallel ports: their structure and usage	2
Lec 7	Count of events and time intervals; timers/counters circuits – their application and programming	2
Lec 8	The course completion test	1
	Total hours:	15

	Laboratory	**Number of hours**
Lab 1	An introduction. Exercises in numbers' notation in positional numeral systems of different bases	2
Lab 2	Elaborating and debugging of a simple program having the structure of a loop. Practical familiarization with the program development environment used in the laboratory, especially with its editor, assembler, and simulator	2
Lab 3	Development and debugging of the programs using data transfer instructions, logical operations and conditional jumps.	4
Lab 4	Selected examples of microcontroller communication with its surroundings via parallel ports: sending data out, reading the state of some input line and reaction to it; elementary microcontroller co-operation with a display, and with a switch.	4
Lab 5	Elaboration of the program of the expanded reaction to the external event.	4
Lab 6	Tables creation in the program memory and the communication with them.	4
Lab 7	Complex tasks decomposition – subroutines separation	2
Lab 8	Data transfer to and from subroutines	2

Lab 9	Elaboration of an exemplary, expanded program controlling a measuring instrument: preliminary assumptions, a state diagram, an algorithm, a code of the program, and debugging procedure	4
Lab 10	Count of events and time intervals; microcontroller build-in counters/timers	3
Lab 11	Practical use of timers	3
Lab 12	An interrupts system of the controller. Practical use of interrupts.	3
Lab 13	Some selected aspect of microcontroller programming in C language: libraries and compiler options	3
Lab 14	Microcontroller programming in C language: a practical training and examples	4
Lab 15	Tests in the course of a semester	1
	Total hours:	45

TEACHING TOOLS USED

N1. Multimedia lecture with elements of a traditional lecture; the elements of lecture are also present during laboratories.
N2. Lecture slides available on the University ePortal.
N3. Data sheets and application notes prepared by the manufacturer of the used microcontroller
N4. In the laboratory: the microcontroller evaluation boards together with exemplary peripheral elements fixed on them, and also PC computers with the appropriate tool programs installed.
N5. The lecture course completion: a written test; The laboratory course completion: pass marks of all short tests in the course of a semester and completion of all the instructed tasks.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02 PEU_U01	A written final test completing the lecture course (colloquium)
F2	PEU_U01	Short tests during the laboratories
F3	PEK_U01 PEU_U02 PEU_U03 PEU_K01 PEU_K02	Individual discussions with students, completing each programming task
P – Lecture: the mark obtained for the written final test (colloquium) P – Laboratory: the marks obtained for tests and for the discussions completing each particular programming task		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Kühnel C., AVR RISC Microcontroller Handbook. Burlington Newnes, 1998; ISBN0-7506-9963-9; ISBN1-322-05218-2; ISBN0-08-049973-2
[2] Morton J., AVR: an Introductory Course. Newnes, 2002. ISBN: 9780750656351 ISBN: 0750656352, EISBN: 9780080499727, EISBN: 0080499724
[3] [Microcontroller datasheet:] 8-bit AVR Microcontroller ATmega128A [a producer document no.:] Atmel-8151J-8-bit AVR [contained in a pdf file named:] Atmel-8151-8-bit-AVR-ATmega128A_Datasheet [available on the course page of ePortal]
[4] Atmel AVR 8-bit Instruction Set. [a producer document no.:] 0856J–AVR–07/2014 [contained in a pdf file named:] Atmel-0856-avr-instruction-set-manual [available on the course page of ePortal]
[4] EasyAVR128™ Development Board Users Manual. LogiFind. [contained in a pdf file named:] EasyAVR128 User Manual [available on the course page of ePortal]

SECONDARY LITERATURE:

[1] Baranowski R., Mikrokontrolery AVR Atmega w praktyce. Wydawnictwo BTC, Warszawa, 2005.
[2] Doliński J., Mikrokontrolery AVR w praktyce., Wydawnictwo BTC, Warszawa, 2003.
[3] Pawluczuk A., Sztuka programowania mikrokontrolerów AVR. Podstawy. Wydawnictwo BTC, Warszawa, 2006.
[4] Pawluczuk A., Sztuka programowania mikrokontrolerów AVR. Przykłady. Wydawnictwo BTC, Warszawa, 2007.
[5] Datasheets of the selected integrated circuits used in the laboratory evaluation boards.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr inż. Grzegorz Smołalski (grzegorz.smolalski@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish STATYSTYKA I RACHUNEK PRAWDOPODOBIEŃSTWA
Name of subject in English STATISTICS AND PROBABILITY THEORY
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30	30			
Number of hours of total student workload (CNPS)	75	75			
Form of crediting	Examination / ~~crediting with grade~~*	~~Examination /~~ crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	3	3			
including number of ECTS points for practical classes (P)		3			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,44	1,28			

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Basic calculus
Basic linear algebra

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SUBJECT OBJECTIVES

C1 Getting acquainted with analysis of empirical data.
C2 Getting acquainted with basic notions of probability theory and their applications in mathematical modelling.
C3 Learning how to create statistical models.
C4 Learning how to choose numerical algorithms for given statistical models.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 has basic knowledge about modelling random phenomena, using probabilistic models and their statistical analysis.

relating to skills:

PEU_U01 can calculate with probabilistic models data.

PEU_U02 can choose statistical procedures for given experimental data.

relating to social competences:

PEU_K01 can use the literature recommended for the course and software tools.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Random phenomena, measurement errors, gathering data and their presentation. Mathematical models of random phenomena and deterministic relations. Empirical distribution, empirical moments, empirical distribution function, histogram, sample quantiles.	4
Lec 2	Probabilistic space. Examples.	2
Lec 3	Conditional probability. Idependence of events.	2
Lec 4	Random variable and its distribution. Multidimensional random variables. Independence of random variables. Density, marginal density, quantiles.	2
Lec 5	Parametrization of distributions of random variables, expected value, higher order moments, variance, conditional expectation.	2
Lec 6	Overview of distributions and their genealogy: Bernoulli, Poisson, geometric and normal distributions.	2
Lec 7	Sources of new distributions. Exponential distribution, Weibull's distribution, gamma distribution, chi-square distribution, beta distribution.	2
Lec 8	Markov's and Chebyshev's inequalities, Law of large numbers, Lindeberg-Levy'si and Lapunov's Central limit theorems.	2
Lec 9	Statistics as a discipline that helps modelling random events. Statistics and their distributions as basic tools in statistical inference. Importance of the size of a sample.	2
Lec 10	Point estimation, properties of estimators, method of moments, maximal likelihood method.	2
Lec 11	Confidence intervals.	2
Lec 12	Testing of hypothesis. Type 1 and 2 errors.	2
Lec 13	Nonparametric tests. chi-square consistency test, Neyman's test, chi-square independence test, Wilcoxon-Mann-Whitney's test.	2
Lec 14	Covariance matrix, correlation coefficient, linear regression, the least squares estimators. Prediction.	2
	Total hours	30

Classes		Number of hours
Cl 1	Solving problems illustrating the theory lectured about.	26
Cl 2	Test	2
Cl 3	Project presentation. Discussion.	2
	Total hours	30

TEACHING TOOLS USED
N1. Lecture using board N2. Solving exercises with students N3. Consulting

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU W01	test
F2	PEU_U01 PEU_U02 PEU_K01	small tests, oral presentations
F3	PEU_W01 PEU_U01 PEU_U02	exam

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Moore D., MacCabe G., Introduction to the Practice of Statistics, Freeman, 2003
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
prof. dr hab. Michał Morayne (michal.morayne@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish PROGRAMOWANIE APLIKACJI MOBLINYCH
Name of subject in English MOBILE APPLICATION DEVELOPMENT
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30	45	
Number of hours of total student workload (CNPS)	50		50	100	
Form of crediting	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	2		2	4	
including number of ECTS points for practical classes (P)			2	4	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,28		1,28	1,88	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

It is required to pass the following course: Introduction to Object-Oriented Programming.

SUBJECT OBJECTIVES

C1 Introduction to programming in Kotlin language for Android software development
C2 Understand the fundamental principles of mobile application development

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 understands the principles of object-oriented programming in Kotlin.

PEU_W02 understands the anatomy of Android application.

PEU_W03 understands Android application and activity lifecycles.

relating to skills:

PEU_U01 can find the software, technical documentation, and information necessary to complete the development tasks related to mobile platforms.

PEU_U02 can implement mobile apps which make use of Internet communication protocols, relational and non-relational databases.

PEU_U03 can implement Mobile Health Android apps.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Kotlin fundamentals	2
Lec 2	Functions	2
Lec 3	Classes and objects	2
Lec 4	Extensions	2
Lec 5	Generics	2
Lec 6	Functional manipulation	2
Lec 7	RecyclerView	2
Lec 8	Room database	2
Lec 9	Connecting to the Internet	2
Lec 10	Repository and WorkManager	2
Lec 11	Notifications	2
Lec 12	Animation and Advanced Graphics	2
Lec 13	Google Maps in Android app	2
Lec 14	Firebase	2
Lec 15	Final test	2
	Total hours	30

Laboratory		**Number of hours**
Lab 1	Setting up Android Studio development environment	2
Lab 2	Creating an example Android app. Anatomy of an Android app	2
Lab 3	Android layouts	2
Lab 4	Navigation	2
Lab 5	Acitivity and Fragment lifecycles	2
Lab 6	Hardware sensors	2
Lab 7	RecyclerView	2
Lab 8	Room database	2
Lab 9	Connecting to the Internet	2
Lab 10	Repository and WorkManager	2

Lab 11	Notifications	2
Lab 12	Advanced Graphics	2
Lab 13	Animation	2
Lab 14	Google Maps in Android app	2
Lab 15	Firebase	2
	Total hours	30

Project		**Number of hours**
Proj 1-6	Project 1	18
Proj 7	Project Presentation	3
Proj 8-14	Project 2	21
Proj 15	Project Presentation	3
	Total hours	45

TEACHING TOOLS USED

N1. Traditional lecture
N2. Computer laboratory – solving tasks
N3. Lab reports
N4. Consultations
N5. Self-study
N6. Digital resources (ePortal PWr)

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02 PEU_W03	Final test
F2	PEU_U01 PEU_U02 PEU_U03	Lab reports
F3	PEU_U01 PEU_U02 PEU_U03	Project 1
F4	PEU_U01 PEU_U02 PEU_U03	Project 2
P = F1 (final test on lecture) P = F2 (laboratory) P = weighted average of F3 and F4 (project)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Philips P., Stewart C., Marsicano K., Android Programming: The Big Nerd Ranch Guide (4th Edition), 2019
[2] Skeen J., Greenhalgh D., Kotlin Programming: The Big Nerd Ranch Guide (2nd Edition), 2021

SECONDARY LITERATURE:

[1] Android documentation (https://developer.android.com/docs)

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr hab. inż. Mirosław Łątka (miroslaw.latka@pwr.edu.pl)
dr inż. Klaudia Kozłowska (klaudia.kozlowska@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish WSTĘP DO FIZJOLOGII
Name of subject in English INTRODUCTION TO PHYSIOLOGY
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical*~~
Level and form of studies: 1st/ ~~2nd level~~, ~~uniform magister studies*~~, ~~full-time / part-time*~~
Kind of subject: obligatory ~~/ optional / university-wide*~~
Subject code ……
Group of courses YES / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15				
Number of hours of total student workload (CNPS)	25				
Form of crediting	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	1				
including number of ECTS points for practical classes (P)					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,68				

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

None

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SUBJECT OBJECTIVES

C1 Acquiring knowledge of the basic conceptual categories related to the human physiology of the functioning of the human body.
C2. Acquiring basic knowledge about the functions of the human body and their regulation at the levels: molecular, cell, tissue, and the whole body.
C3 Acquiring knowledge of the methodology of physiological tests of organs and systems
C4 Acquiring the ability to work in a physiology laboratory and mastering the skills preparation of reports on the conducted laboratory work.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 knows and understands to a greater extent selected facts, objects, and phenomena as well as methods and theories related to them, which constitute advanced general knowledge in the field of study programs related to Biomedical Engineering.

relating to social competences:

PEU_K01 is ready to create and develop patterns of proper conduct in work and living environment.

PEU_K02 is ready to lead the group and take responsibility for it.

PEU_K03 is ready to fulfill social obligations, inspire and organizing activities for the benefit of the social environment.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Introduction to physiology, basic concepts and general characteristics of human physiology	1
Lec 2	Homeostasis and its mechanisms	2
Lec 3	Physiology of the motor system and the nervous system	2
Lec 4	Cardiovascular and lymphatic system physiology	2
Lec 5	Fluid management - the physiology of the excretory system	2
Lec 6	Digestive system physiology	2
Lec 7	Respiratory system physiology	2
Lec 8	Endocrine system physiology	2
	Total hours	15

TEACHING TOOLS USED

N1 The blackboard and the marker as a teaching aid during the laboratory and lecture
N2 Multimedia presentations
N3 Data sheets of device manufacturers, material safety data sheets, instructions on lab
N4 Computer and software for multimedia presentations at the lecture

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU _W01 PEU _K01 PEU _K02 PEU _K03	Test examination
P1 lecture – grade from the exam (test)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] John T. Hansen, Bruce M. Koeppen, Frank H. Netter, „Atlas fizjologii człowieka Nettera" Elsevier Urban & Partner, Wrocław 2005 wyd. 1
[2] W.Z. Traczyk i A. Trzebski: „Fizjologia człowieka z elementami fizjologii stosowanej i klinicznej". PZWL, Warszawa 2004

SECONDARY LITERATURE:

[1] Fizjologia człowieka. Podręcznik dla studentów medycyny
[2] S. Konturek t.II. Układ krążenia. wydawnictwo UJ, Kraków 2000 t. III. Oddychanie, czynności nerek, równowaga kwasowo zasadowa, płyny ustrojowe. wyd. UJ, Kraków 2001 t. IV. Neurofizjologia. wyd. UJ, Kraków 1998 t. V. Układ trawienny i wydzielanie wewnętrzne. wyd. UJ. Kraków 2000

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr hab. inż. Magdalena Przybyło (magdalena.przybylo@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY: Fundamental Problems of Technology / DEPARTMENT: Biomedical Engineering

SUBJECT CARD

Name of subject in Polish: PROGRAMOWANIE W PYTHONIE
Name of subject in English: PROGRAMMING IN PYTHON
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st/ ~~2nd~~ level, ~~uniform magister studies~~*, full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code: …….
Group of courses: YES / ~~NO~~*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)			45		
Number of hours of total student workload (CNPS)			75		
Form of crediting	Examination / crediting with grade*	Examination / crediting with grade*	~~Examinatio n~~ / crediting with grade*	Examination / crediting with grade*	Examinatio n / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points			3		
including number of ECTS points for practical classes (P)			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)			1,88		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

The student:
1. has knowledge of fundamentals of programming, including design of algorithms and data structures, and elementary techniques of modern programming, including object-oriented programming
2. can design, implement, and analyse programs solving medium complexity task
3. can create programs in the object-oriented paradigm
4. can debug developed programs
5. can communicate using computer science terminology.

SUBJECT OBJECTIVES

C1. To gain essential knowledge of Python programming language ecosystem and its features relevant to Medical Informatics.
C2. To learn essential practical skills in programming in Python with emphasis on techniques relevant to Medical Informatics.

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge

PEU_W01: Has essential knowledge of Python programming language ecosystem and its features relevant to Medical Informatics

Relating to skills

PEU_U01 can write programs in Python, up to intermediate level of complexity, with emphasis on solving tasks relevant to Medical Informatics.

Relating to social competences

PEU_K01 knows the scope of his/her knowledge, is prepared to expand it.

PROGRAMME CONTENT

Laboratory		**Number of hours**
Lab 1	Introduction to the laboratory. The rules of the class. Introduction to the programming environment	2
Lab 2-3	Writing procedural code in the Pythonic way for Java programmers	4
Lab 4-5	Performing input/output operations. Processing sequential data	4
Lab 7-9	Writing object-oriented code in the Pythonic way for Java programmers	6
Lab 10	Dealing with tabular data	2
Lab 11	Test list no. 1	2
Lab 12-13	Visualizing data	4
Lab 14-15	Processing multidimensional numerical data	4
Lab 16-17	Dealing with graphical representations: trees and networks	4
Lab 18-19	Writing functional and reflective code in Python	4
Lab 20	Test list no. 2	2
Lab 21-23	Miniproject	7
	Total hours	45

TEACHING TOOLS USED

N1. Hands-on tutorials
N2. Lists of tasks to be solved individually
N3. Tests (written or online)
N4. Individual or group project
N5. Laboratory and project — computer and software including IDE

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation F – forming during semester, P – concluding at semester end	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_U01 PEU_K01	Assignments: lists of tasks (incl. miniproject)
F2	PEU_W01 PEU_U01 PEU_K01	Test lists

P = (2/3 F1 + 1/3 F2) if F2 ≥ 3.0, else 2.0, where Fi with $i \in \{1, 2\}$ is the arithmetic average calculated over respective lists.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE

[1] Allen Downey (2015) Think Python. How to Think Like a Computer Scientist. 2nd Edition. Green Tea Press
[2] Anthony Scopatz & Kathryn D. Huff (2015) Effective Computation in Physics. O'Reilly
[3] Sofía De Jesús & Dayrene Martinez (2020) Applied Computational Thinking with Python. Packt Publishing.

SECONDARY LITERATURE

[1] David Mertz (2015) Functional Programming in Python. O'Reilly Media.
[2] Harriet Dashnow, Juan Nunez-Iglesias, & Stéfan van der Walt (2017) Elegant SciPy. O'Reilly Media.
[3] Web-platforms for programmers, e.g., stackoverflow.com

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr hab. inż. Witold Dyrka (witold.dyrka@pwr.edu.pl)
dr hab. inż. Cezary Sielużycki (cezary.sieluzycki@pwr.edu.pl)
dr inż. Agnieszka Kazimierska (agnieszka.kazimierska@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish BIOCHEMIA
Name of subject in English BIOCHEMISTRY
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30				
Number of hours of total student workload (CNPS)	50				
Form of crediting	Examination / ~~crediting with grade*~~	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	2				
including number of ECTS points for practical classes (P)					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,44				

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Knowledge of chemistry and biology

SUBJECT OBJECTIVES

C1 Introduction to basic concepts of protein and carbohydrate biochemistry, as well as the mechanisms governing the pathways of biological signal transmission
C2 Introduction to theoretical foundations of techniques for working with biomolecules, obtaining basic knowledge about the kinetics of enzymatic reactions, obtaining knowledge about biological membranes, learning the basic concepts and organization of metabolism, acquainting with the basic knowledge about the structure of nucleic acids, methods of molecular biology and transfer of genetic information
C3 Introduction to basic concepts of molecular motors

SUBJECT EDUCATIONAL EFFECTS
relating to knowledge: PEU_W01 has a basic knowledge of biochemistry

PROGRAMME CONTENT		
Lecture		**Number of hours**
Lec 1	Introduction to biochemistry	2
Lec 2	Macromolecules	2
Lec 3	Structure and function of proteins	2
Lec 4	Protein analysis methods	2
Lec 5	Amyloidogenic proteins.	2
Lec 6	Proteins and disease entities	2
Lec 7	Enzymes	2
Lec 8	Enzymatic catalysis	2
Lec 9	Biological signaling pathways	2
Lec 10	Metabolism	2
Lec 11	Nucleic acids (DNA, RNA)	2
Lec 12	Protein biosynthesis	2
Lec 13	Receptors	2
Lec 14	Molecular motors	2
Lec 15	Final test	2
	Total hours	30

TEACHING TOOLS USED
N1. Lecture – multimedia presentation

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01	Final test
P = F1 – final test		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Berg, J. M., L. Stryer, J. L., Tymoczko, G.J. Gatto, Biochemistry. W.H. Freeman and Co., New York 2019
[2] Berg, J. M., Tymoczko, J. L., Stryer, L., Biochemia. PWN S.A., Warszawa 2018 (tłum. 8wydania amerykańskiego)

SECONDARY LITERATURE:

[1] Gumport, R.I., Deis, F.H., Gerber, N.C., Koeppe II, R., Student Companion to Accompany Biochemistry, seventh edition, WH, Freeman 2012
[2] Voet, D., Voet, J.G., Biochemistry. Wiley & Sons, Inc., 3rd edition

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr inż. Marlena Gąsior-Głogowska (marlena.gasior-glogowska@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish BIOFIZYKA
Name of subject in English BIOPHYSICS
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st/ ~~2nd level, uniform magister studies*~~, full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15	15	15		
Number of hours of total student workload (CNPS)	25	50	50		
Form of crediting	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	1	2	2		
including number of ECTS points for practical (P) classes		2	2		
including number of ECTS points for direct teacher-student contact (BK) classes	0,68	0,68	0,68		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Physics 1
2. Physics 2

SUBJECT OBJECTIVES

C1 Lay of the foundation for further studies of the physiology, biosensors, biospectroscopy and basic modeling of biophysical phenomena

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 has ordered, theoretically founded general knowledge covering key issues in the field of biophysics of biological systems. Has knowledge of occupational health and safety.

relating to skills:

PEU_U01 can correctly and effectively apply the learned principles and laws of biophysics to qualitative and quantitative analysis of practical engineering issues in the field of biophysical aspects of biotechnology.

PEU_U02 can correct and efficiently solve simple biophysical or biomedical problems. Can correctly interpret the results obtained during the experiment and assess their credibility.

relating to social competences:

PEU_K01 is able to work in a team, is aware of taking responsibility for jointly performed tasks.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Biological membranes, model lipid membranes - experimental and theoretical research	2
Lec 2	Fundamentals of thermodynamics in the description of physicochemical phenomena occurring in biological systems	2
Lec 3	Diffusion, osmosis, Nernst equilibrium	2
Lec 4	Transport across membranes	2
Lec 5	Filtration, ultrafiltration, Kedem-Katchalski equation	2
Lec 6	Ion channels, selectivity, gate mechanism. Nerve cell membrane biophysics	2
Lec 7	Continuation of the lecture 6	2
Lec 8	Final test	1
	Total	**15**

	Classes	**Number of hours**
Cl 1	Task list no. 1 - calculating the concentrations of mixtures of solutions	2
Cl 2	Task list no. 2 - dilution error analysis	2
Cl 3	Task list no. 3 - the flow of an ideal liquid	2
Cl 4	Task list no. 4 - the flow of viscous liquid	2
C1 5	Task list no. 5 - work, energy, power in biological systems	2
C1 6	Task list no. 6 - thermodynamics of biological systems	2
Cl 7	Task list no. 7 - the analysis of the similarity	2
C1 8	Final test	1
	Total hours	15

Laboratory		Number of hours
Lab 1	Introduction (regulations, discussion of the theory of measurement errors)	3
Lab 2	Nernst potential measurements	3
Lab 3	Dialysis	3
Lab 4	Study of the kinetics of the release of substances from the ointment	3
Lab 5	Study of the mechanisms of adsorption on activated carbon	3
	Total hours	15

TEACHING TOOLS USED

N1. Multimedia lecture
N2. Traditional lecture
N3. Accounting exercises
N4. Experimental (laboratory) work

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating educational effect achievement
F1	PEU_W01 PEU_K01	Final test
F2	PEU_W01 PEU_U01 PEU_U02	Evaluation of theoretical preparation and evaluation of report of each exercise
F3	PEU U02	Proficiency check in solving tasks in biophysics

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Jaroszyk F., Biofizyka, PZWL, Warszawa 2009
[2] Jóźwiak Z., Bartosz G., Biofizyka. Wybrane zagadnienia wraz z ćwiczeniami. PWN, Warszawa, 2005
[3] Miękisz S., Hendrich A., Wybrane zagadnienia z biofizyki, Wyd. AM, Wrocław, 1996

SECONDARY LITERATURE:

[1] Podstawy biologii komórki, Bruce Alberts, Karen Hopkin, Alexander Johnson, Martin Raff, Keith Roberts, Peter WalterPWN, Warszawa 2019
[2] Dołowy K., Szewczyk A., Pikuła S., Błony biologiczne. Śląsk, 2003
[3] Traczyk Z., Trzebski A., Fizjologia człowieka z elementami fizjologii stosowanej i klinicznej, PZWL, Warszawa 2004

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

prof. dr hab. Krystian Kubica (krystian.kubica@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish ELEKTRONICZNA APARATURA MEDYCZNA
Name of subject in English ELECTRONICAL INSTRUMENTATION
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st/ ~~2nd level, uniform magister studies*~~, full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		15		
Number of hours of total student workload (CNPS)	50		50		
Form of crediting	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	2		2		
including number of ECTS points for practical classes (P)			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,28		0,68		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

W: Completion of the courses:

- Introduction to Medical Electronics 1
- Introduction to Medical Electronics 2
- Introduction to Physiology

SUBJECT OBJECTIVES

C1 Understand the basis of biomedical signals that might be monitored by an electronic device or system

C2 Understand the important electronic components in a modern biomedical measurement system

C3 Ability to specify a basic biomedical measurement system

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 describes the physiological processes that generate biomedical signals and the mathematical or electrical characteristics of such signals.

PEU_W02 explains how various sensors pick up the biomedical signals and convert them to a useful electronic signal within the measurement device.

PEU_W03 for a given biomedical measurement system, describes the electronic components involved.

PEU_W04 for a given biomedical measurement system, explains the purpose and the operation of the electronic components involved.

relating to skills:

PEU_U01 is able to use the basic electromedical diagnostic and therapeutic devices.

PEU_U02 is able to ensure the proper condition for working of these devices.

PEU_U03 is able to assess the technical and functional properties of these devices.

relating to social competences:

PEU_K01 knows the limitations of his own knowledge and understand the need for further education.

PEU_K02 be able to formulate questions to deepen his own understanding subject.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Electromedical instrumentation - basic concepts and diagrams	2
Lec 2	Electrical safety	2
Lec 3	Biopotentials: origin and electrodes	2
Lec 4	Biopotential amplifiers	2
Lec 5	Cardiology instrumentation	2
Lec 6	Electromyographic instrumentation	2
Lec 7	Electroencephalographic instrumentation	2
Lec 8	Noninvasive Arterial Blood Pressure and Mechanics	2
Lec 9	Audiometry instrumentation	2
Lec10	Testing of Respiratory System	2
Lec 11	Oximetry and Pulse Oximetry	2
Lec 12	Medical robots	2
Lec 13	Mechanical ventilation	2
Lec 14	External and Implantable Defibrillators	2
Lec 15	Electrosurgical devices	2
	Total hours	30

Laboratory		**Number of hours**
Lab 1	Electroencephalography measurement	3
Lab 2	Electrocardiology measurement	3
Lab 3	Electromyography measurement	3
Lab 4	Audiology measurement	3
Lab 5	Spirometry measurement	3

	Total hours	15

TEACHING TOOLS USED

N1. Multimedia lecture
N2. Materials posted on e-portal.pwr.edu.pl
N3. Equipment in the Electromedical Instrumentation laboratory
N4. Consultation

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02 PEU_W03 PEU_W04	1. Exam
F2	PEU_U01 PEU_U02 PEU_U03	1. Test during laboratory 2. Reports on lab experiments
P=F1 lecture – assessment based on the exam P= F2 lab – assessment based on the average of the tests and reports		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Fundamentals of Biomedical Engineering, G.S. Sawhney, New Age International Publishers, 2007
[2] Medical Instrumentation Application and Design, J.G.Webster, JohanWilney&Sons, 2010
[3] Biomedical Technology and Devices handbook, J. Moore, G. Zouridakis, CRCPress, 2004

SECONDARY LITERATURE:

[1] Introduction to Biomedical Equipment Technology, J.Carr, J. Brown, 2000
[2] Biomedical Engineering, M. Salzman, 2009

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr inż. Wioletta Nowak (wioletta.nowak@pwr.edu.pl)
dr inż. Elżbieta Szul-Pietrzak (elzbieta.szul-pietrzak@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish TECHNOLOGIE SIECIOWE
Name of subject in English NETWORK TECHNOLOGIES
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st/ ~~2nd level, uniform magister studies*~~, full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30	45	
Number of hours of total student workload (CNPS)	75		75	100	
Form of crediting	Examination / ~~crediting with grade*~~	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	3		3	4	
including number of ECTS points for practical classes (P)			3	4	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,44		1,28	1,88	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

It is required to pass the following courses: Introduction to Object-Oriented Programming and Databases.

SUBJECT OBJECTIVES

C1 Gaining basic knowledge on LAN and WAN networks
C2 Gaining basic knowledge on Internet architecture and communication protocols
C3 Learning web application development using various communication protocols

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 knows architecture of computer networks.
PEU_W02 knows communication protocols and web services.
PEU_W03 acquires knowledge of computer network security.

relating to skills:
PEU_U01 is able to monitor network devices and computer networks.
PEU_U02 is able to manage web services.
PEU_U03 is able to implement web application in client-server model.

relating to social competences:
PEU_K01 is aware of limitations of his/her knowledge and understands the need for further development.
PEU_K02 is able to act creatively and enterprisingly during web application development.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Computer networks – topologies and definitions, ISO/OSI and TCP/IP	2
Lec 2	IPv4 addressing, network devices, transmission media, wireless networks, network commands	2
Lec 3	HTML and CSS	2
Lec 4	Bootstrap	2
Lec 5-7	Java Network programming – JEE (JSP, servlets, JDBC)	6
Lec 8	Introduction to JavaScript	2
Lec 9-13	ReactJS web app development (hooks, redux, router etc.)	10
Lec 14	Network security, e-mail, routing, VPN, and proxy	2
Lec 15	Final test	2
	Total hours	30

Laboratory		**Number of hours**
Lab 1	Fundamentals of computer networks	2
Lab 2	Packet analysis in Wireshark	2
Lab 3	HTML, CSS, and Bootstrap	2
Lab 4-7	JEE: JSP, servlets, and JDBC	8
Lab 8-9	JEE project	4
Lab 10-15	ReactJS web app development	12
	Total hours	30

Project		Number of hours
Proj 1-6	Project (JEE)	18
Proj 7	Project Presentation	3
Proj 8-14	Project (ReactJS and NoSQL)	21
Proj 15	Project Presentation	3
	Total hours	45

TEACHING TOOLS USED
N1. Traditional lecture N2. Computer laboratory – solving tasks N3. Lab reports N4. Consultations N5. Self-study N6. Digital resources (ePortal PWr) N7. Quizzes

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02 PEU_W03	Final test
F2	PEU_U01 PEU_U02 PEU_U03	Lab reports
F3	PEU_U01 PEU_U02 PEU_U03	Quizzes
F4	PEU_U01 PEU_U02 PEU_U03 PEU_K01 PEU_K02	Short project
F5	PEU_U01 PEU_U02 PEU_U03 PEU_K01 PEU_K02	Project 1
F6	PEU_U01 PEU_U02 PEU_U03	Project 1

	PEU_K01 PEU_K02	
P = F1 (final test on lecture) P = weighted average of F2-F4 (laboratory) P = weighted average of F4 and F5 (project)		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Tanenbaum, A.S., Computer Networks (5th Edition), 2010 [2] Robbins, J., Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics (5th Edition), 2018 [3] Stefanov, S., React: Up & Running: Building Web Applications, 2016 [4] Chinnathambi, K., Learning React: A Hands-On Guide to Building Web Applications Using React and Redux (2nd Edition), 2018 **SECONDARY LITERATURE:** [1] Kurose, J., Ross, K., Computer Networking: A Top-Down Approach (7th Edition), 2016 [2] ReactJS documentation (https://pl.reactjs.org/docs/getting-started.html) [3] Apache Tomcat documentation (http://tomcat.apache.org/tomcat-8.0-doc/index.html)
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
dr inż. Klaudia Kozłowska (klaudia.kozlowska@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY FUNDAMENTAL PROBLEMS OF TECHNOLOGY / DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish WSTĘP DO BIOINFORMATYKI
Name of subject in English INTRODUCTION TO BIOINFORMATICS
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st/ ~~2nd level, uniform magister studies*, full-time / part-time~~*
Kind of subject: ~~obligatory /~~ optional ~~/ university-wide*~~
Subject code …….
Group of courses ~~YES /~~ NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30		
Number of hours of total student workload (CNPS)	50		100		
Form of crediting	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	2		4		
including number of ECTS points for practical classes (P)			4		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,68		1,28		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of biochemistry
2. Programming skills

SUBJECT OBJECTIVES

C1 Introduction to algorithms for computational solving problems of molecular biology
C2 Developing general programming skills

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 has theoretically founded general knowledge including the use of computational methods in the field of biological sequence processing.

relating to skills:

PEU_U01 can correctly and effectively use the theoretical knowledge to build their own algorithm and effectively implement it.

relating to social competences:

PEU_K01can formulate opinions on the basic issues of bioinformatics.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Course overview. Tree of life - kinship of organisms and algorithms	1
Lec 2	Dynamic programming. Pairwise homologue alignment algorithms	2
Lec 3	Algorithms for multiple sequence alignment	2
Lec 4	Modeling the rate of evolution - models and algorithms	2
Lec 5	Modeling phylogenetic trees - models and algorithms	2
Lec 6	Network models in bioinformatics - algorithms	2
Lec 7	Network models applied for interaction and regulatory molecular networks	2
Lec 8	Final test	2
	Total hours	15

	Laboratory	**Number of hours**
Lab 1	Scope and regulations. Databases as sources of molecular data. Dot-plot for sequence alignment – introduction.	2
Lab 2	Task 1: Dot-plot in pairwise sequence alignment	2
Lab 3	Task 2: Global pairwise sequence alignment – introduction	2
Lab 4	Task 2 continued: Global pairwise sequence alignment	2
Lab 5	Task 2 continued: Global pairwise sequence alignment	2
Lab 6	Task 3: Local pairwise sequence alignment – introduction	2
Lab 7	Task 3 continued: Local pairwise sequence alignment	2
Lab 8	Presentation of individual programs of tasks 1-3	2
Lab 9	Task 4: Multiple Sequence Alignment – introduction	2
Lab 10	Task 4 continued: Multiple Sequence Alignment	2
Lab 11	Task 5: Phylogenetic Tree or Network model - introduction	2
Lab 12	Task 5 continued: Phylogenetic Tree or Network model	2
Lab 13	Task 5 continued: Phylogenetic Tree or Network model	2
Lab 14	Presentation of individual programs of tasks 4 and 5	2
Lab 15	Completion of the laboratory, overdue tasks	2
	Total hours	30

TEACHING TOOLS USED
N1. Board, computer, projector N2. Programming tasks for independent implementation N3. Scripting programming language and software N4. Bioinformatics services as a source of data

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEK_W01	A grade from evaluation test
F2	PEK_U01 PEK_K01	Grades from all tasks
P = F1 – lecture – grade from the test P = F2 – laboratory – average of the grades from all practical tasks		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] P. G. Higgs, T.K. Atwood, Bioinformatyka i ewolucja molekularna, PWN 2012 **SECONDARY LITERATURE:** [1] A. Isaev, Introduction to Mathematical Methods in Bioinformatics, Springer-Verlag Berlin Heidelberg 2006.
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
prof. dr hab. inż. Małgorzata Kotulska (malgorzata.kotulska@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish ANALIZA SZEREGÓW CZASOWYCH
Name of subject in English TIME SERIES ANALYSIS
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: ~~obligatory~~ / optional / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30		
Number of hours of total student workload (CNPS)	50		100		
Form of crediting	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	2		4		
including number of ECTS points for practical classes (P)			4		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,68		1,28		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Python programming

SUBJECT OBJECTIVES

C1 Gaining basic knowledge on time series analysis
C2 Gaining basic knowledge on forecasting and modelling of time series

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 has deeper knowledge of statistical theory and methods particularly common in time series modelling and forecasting.
PEU_W02 understands time-dependent seasonal components.
PEU_W03 is able to interpret the results of an implemented analysis.
PEU_W04 is aware of limitations and possible sources of errors in the analysis.

relating to skills:
PEU_U01 can use Python in time series analysis.
PEU_U02 can apply auto-regressive and model averaging models.
PEU_U03 can forecast time series using Deep Learning methods.
PEU_U04 can extract time series' features using Wavelet transform.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Course requirements, Python Pandas Overview	2
Lec 2	Time series visualization	2
Lec 3-4	Forecasting with smoothing models	4
Lec 4-6	ARMA, ARIMA, and SARIMA models	6
Lec 7	Vector autoregression and Granger causality	2
Lec 8	Time series forecasting using Prophet library	2
Lec 9-11	Deep Learning for Time Series Forecasting	6
Lec 12-13	Wavelet analysis in feature extraction	4
Lec 14	Time series clustering using k-shape algorithm	2
Lec 15	Final test	2
	Total hours	30

Classes		**Number of hours**
Cl 1	Python Pandas Overview	2
Cl 2	Time series visualization	2
Cl 3	Forecasting with smoothing models	2
Cl 4-5	ARMA model	4
Cl 6-7	ARIMA and SARIMA models	4
Cl 8	Vector autoregression and Granger causality	2
Cl 9	Time series forecasting using Prophet library	2
Cl 10-11	Deep Learning for Time Series Forecasting	4
Cl 12-13	Wavelet analysis in feature extraction	4
Cl 14	Time series clustering using k-shape algorithm	2

Cl 15	Final project presentation	2
	Total hours	30

TEACHING TOOLS USED
N1. Traditional lecture N2. Lab reports N3. Consultations N4. Self-study N5. Digital resources (ePortal PWr) N6. Quizzes N7. Final project (chosen topic) N8. Final test

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02 PEU_W03 PEU_W04	Final test
F2	PEU_U01 PEU_U02 PEU_U03 PEU_U04	Lab reports
F3	PEU_U01 PEU_U02 PEU_U03 PEU_U04	Quizzes
F4	PEU_U01 PEU_U02 PEU_U03 PEU_U04 PEU_U05	Final project
P = weighted average of F1- F4		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Hyndman, Rob J., and George Athanasopoulos. Forecasting: principles and practice. OTexts, 2018.
[2] Nielsen, Aileen. Practical time series analysis: Prediction with statistics and machine learning. O'Reilly Media, 2019.
[3] Addison, Paul S. The illustrated wavelet transform handbook: introductory theory and applications in science, engineering, medicine and finance. CRC press, 2017.

SECONDARY LITERATURE:

[1] Taylor, Sean J., and Benjamin Letham. "Forecasting at scale." The American Statistician 72.1 (2018): 37-45.
[2] Torrence, Christopher, and Gilbert P. Compo. "A practical guide to wavelet analysis." Bulletin of the American Meteorological society 79.1 (1998): 61-78.
[3] Patel, Ankur A. Hands-on unsupervised learning using Python: how to build applied machine learning solutions from unlabeled data. O'Reilly Media, 2019.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr hab. inż. Mirosław Łątka (miroslaw.latka@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish CYFROWE PRZETWARZANIE SYGNAŁÓW
Name of subject in English DIGITAL SIGNAL PROCESSING
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	50		75		
Form of crediting	Examination / ~~crediting with grade~~*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	2		3		
including number of ECTS points for practical classes (P)			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,44		1,28		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Mathematical analysis 1 and 2
2. Algebra and analytic geometry
3. Introduction to programming
4. Statistics and probability theory

SUBJECT OBJECTIVES

C1 Acquiring knowledge in the field of characterizing deterministic and random signals, methods of their analysis, basic algorithms, continuous and discrete transformations used in the theory and practice of digital signal processing.
C2 Acquiring skills in the field of application of digital signal processing methods and techniques to solve problems of simulation and analysis of a wide spectrum of signals.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 recognizes and understands the methods of signal differentiation due to their general properties, distinguishes between signal classes, is able to choose appropriate methods of description and analysis of a specific signal.

PEU_W02 knows the basic concepts, transformations, methods, and algorithms of digital signal processing and is able to define their properties and the area of application.

relating to skills:

PEU_U01 can correctly identify problems in the field of signal processing, can effectively use basic digital methods and algorithms for the characterization and analysis of signals, as well as use them in simulation modelling when solving engineering tasks, can correctly interpret the obtained results.

PEU_U02 can use the literature in the field of digital signal processing as well as the information contained in the DSP software help/documentation.

relating to social competences:

PEU_K01 knows the scope of his/her knowledge, is prepared to expand it.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Introduction, motivation, lecture programme, conditions for passing. Sinusoidal signals, discrete form of the signal (sampling), basic parameters of continuous and discrete signals.	2
Lec 2	The canonical and trigonometric form of complex numbers. Euler's formula. Complex amplitude. Phase shift. Addition of phasors.	2
Lec 3	Addition of sinusoidal signals. Amplitude spectrum. Phase spectrum.	2
Lec 4	The symmetric nature of the spectrum. Harmonics. Fundamental frequency. Signal-to-noise ratio.	2
Lec 5	Time vs frequency. The uncertainty principle in signal analysis. Fourier transformation. Complex coefficients. Fourier series. Signal synthesis vs analysis.	2
Lec 6	Sampling and quantization of the signal. Analogue-to-digital conversion. Sampling theorem. Digital frequency. Discrete signal spectrum. Aliasing in time domain.	2
Lec 7	Aliasing in two-dimensional space. Beat. Spectral leakage. Signal windowing.	2
Lec 8	Linear systems. Convolution. Z transformation. Filters with finite impulse response.	2
Lec 9	Filters with infinite impulse response. Designing digital filters.	2
Lec 10	Random signals. Stationarity and non-stationarity of signals. The Wiener–Khinchin theorem. Random signals in linear systems.	2
Lec 11	Time-frequency analysis. Short-term Fourier transformation. Spectrogram. The problem of choosing a window.	2
Lec 12	Continuous wavelet transformation. Discrete wavelet transformation.	2
Lec 13	Adaptive approximations of signals. Matching pursuits with time-frequency dictionaries.	2
Lec 14	Applications of digital signal processing in biomedicine.	2
Lec 15	Applications of digital signal processing in biomedicine, continued.	2
	Total hours	30

Laboratory		Number of hours
Lab 1	General introduction, conditions for passing. Introduction to MATLAB and Octave environments. An example of digital signal processing.	2
Lab 2	Sinusoidal signals. Generation of discrete signals. Sampling.	2
Lab 3	Generation of discrete complex signals. Decimation and resampling.	2
Lab 4	Complex representation of signals. Phasor plots of signals.	2
Lab 5	Basic mathematical operations on complex signals (addition and multiplication).	2
Lab 6	Frequency analysis of deterministic signals.	2
Lab 7	Discrete Fourier transformation, fast Fourier transformation.	2
Lab 8	Signal-to-noise ratio. Aliasing.	2
Lab 9	Spectral leakage. Signal windowing and its spectral properties.	2
Lab 10	Design of digital filters, filters with finite impulse response.	2
Lab 11	Design of digital filters, filters with infinite impulse response.	2
Lab 12	An example of the use of digital filters: the Pan–Tompkins algorithm.	2
Lab 13-14	Time-frequency analysis with short-time Fourier transformation.	4
Lab 15	Wavelet transformations. Matching pursuit.	2
	Total hours	30

TEACHING TOOLS USED
N1. Lecture and computer-aided laboratories. N2. MATLAB and Octave environments. N3. Hands-on tutorials. N4. Lists of tasks to solve. N5. Short tests during laboratories. N6. Written report on the subject selected by the student.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02	1. Exam grade. 2. Half a grade more for significant activity during the lecture.
F2	PEU_U01 PEU_U02 PEU_K01	1. Short written assignments — tests during laboratories. 2. Report on a topic chosen by the student, based on the knowledge and skills acquired during the course.
P — for the lecture, grade received on the exam. P — for the laboratories, arithmetic mean of grades received for activity, tests, and the report.		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] McClellan J. H., Schafer R. W., Yoder M. A., DSP First: A Multimedia Approach, Prentice Hall.
[2] Brockwell P. J., Davis R. A., Introduction to Time Series and Forecasting, Springer.
[3] Mallat S., A Wavelet Tour of Signal Processing: The Sparse Way, Academic Press.
[4] Durka P., Matching Pursuit and Unification in EEG Analysis, Artech House Publishers.

SECONDARY LITERATURE:

[1] McClellan J. H., Schafer R. W., Yoder M. A., DSP First 2e, Georgia Tech.
[2] Mallat S., A Wavelet Tour of Signal Processing, ENS.
[3] Polikar R., The Wavelet Tutorial: The Engineer's Ultimate Guide to Wavelet Analysis, Rowan Uni.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr hab. inż. Cezary Sielużycki (cezary.sieluzycki@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish INŻYNIERIA OPROGRAMOWANIA
Name of subject in English SOFTWARE ENGINEERING
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st/ ~~2nd level, uniform magister studies~~*, full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional / university-wide~~*
Subject code …….
Group of courses YES / ~~NO~~*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30	15	
Number of hours of total student workload (CNPS)	75		75	25	
Form of crediting	Examination / ~~crediting with grade~~*	~~Examination /~~ crediting with grade*	~~Examination /~~ crediting with grade*	~~Examination /~~ crediting with grade*	~~Examination /~~ crediting with grade*
For group of courses mark (X) final course	X				
Number of ECTS points	3		3	1	
including number of ECTS points for practical classes (P)			3	1	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,44		1,28	0,68	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Student

1. Has knowledge of fundamentals of programming, including design of algorithms and data structures, and elementary techniques of modern programming, including object-oriented programming.
2. Can design, implement, and analyze programs solving medium complexity task.
3. Can create programs in the object-oriented paradigm.
4. Can debug developed programs.
5. Can communicate using computer science terminology.

SUBJECT OBJECTIVES

C1 To gain basic knowledge in the field of software engineering and managing programming projects.
C2 To learn basic practical skills in selected modern approaches and techniques of software design and programming project management.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 has essential knowledge of software engineering.
PEU_W02 knows selected essential methodologies and techniques of software design and managing a programming project.

relating to skills:
PEU_U01 can specify the requirements in a programming project in a manner appropriate for Medical Informatics.
PEU_U02 can design an IT system.
PEU_U03 can apply modern techniques for developing IT systems in projects related to Medical Informatics.
PEU_U04 can validate the correctness and quality of the software.

relating to social competences:
PEU_K01 is ready to cooperate and collaborate in a group by taking different roles and showing initiative.
PEU_K02 is ready to make decisions regarding the work organization in a programming project, and to critically evaluate the process.
PEU_K03 observes the professional ethics of the software developer considering the specificity of Medical Informatics.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Introduction to software engineering. Rules for completing the subject, overview of basic concepts, tools and techniques used in software engineering	2
Lec 2	Version control systems. Overview of the role of code versioning, documentation, and the runtime environment. GIT as an example of a distributed version control system	2
Lec 3	Life cycle of an IT project. Overview of the most common models. Creating project documentation	2
Lec 4	Collection and specification of requirements in IT projects. Overview of techniques and tools used	2
Lec 5	Cascade and agile methods of IT project management. Discussing the differences, strengths and weaknesses of various methods of work organization in IT projects	2
Lec 6	Elements of the UML language. Overview of the basic diagrams used to record the requirements and architecture	2
Lec 7	Mid-semester test	2
Lec 8	Unit testing as a basic application development technique. Overview of the RED, GREEN, REFACTOR approach	2
Lec 9	Software testing. Review of software validation methods: integration, performance, regression, functional, usability and acceptance tests	2
Lec 10	Other methods of ensuring the quality of the application. Application runtime virtualization. Overview of metrics and tools supporting code quality	2

	management. Overview of modern techniques of IT resource virtualization, in particular, the methods of containerization	
Lec 11	Continuous integration, continuous delivery. DevOps culture as an indispensable element of a modern IT project	2
Lec 12	Domain modeling. Designing IT systems focused on the business domain	2
Lec 13	Application architecture. Overview of the most common cloud-based solutions today	2
Lec 14	Summary of the most important elements in software engineering. Career in the IT industry – what you should know	2
Lec 15	Final test	2
	Total hours	30

— **usunięto:** Learning problems & techniques: supervised, unsupervised, self- & semi-supervised, reinforcement, transfer learning…

Laboratory		**Number of hours**
Lab 1	Introduction to the laboratory. The rules of the class. Basics of working in Linux. Integrated development environment	2
Lab 2	Version control system as a developer's primary tool	2
Lab 3	Virtualization of the development environment with the use of containers	2
Lab 4-5	Implementation of the application in the cloud environment	4
Lab 6-7	Validating software using unit tests	4
Lab 8-9	Checking the correctness of the software using integration, component and functional tests	4
Lab 10	Collecting code quality metrics	2
Lab 11	A comprehensive approach to the creation of project documentation	2
Lab 12	Build a continuous integration environment	2
Lab 13-14	Code refactoring	4
Lab 15	Final evaluation	2
	Total hours	30
Project		**Number of hours**
Prj 1	Introduction to the project. The rules of the class. Choosing a topic, creating a work plan	1
Prj 2	Exercises in designing information systems – methods of collecting and describing system requirements	2
Prj 3	Definition of the goal, product specification and acceptance criteria; workload estimation. Choice of technology and architecture concepts	2
Prj 4	Exercises in building a software development management process. Workflow, estimation, prioritization, definition of done, definition of ready.	2
Prj 5-6	Implementation of the solution. Work progress review	4
Prj 7-8	Refactoring the solution. Project documentation. Final evaluation	4
	Total hours	15

TEACHING TOOLS USED
N1. Lecture – multimedia presentation N2. Project – a group project task N3. Laboratory – lists of tasks to be solved individually N4. Laboratory – sample tasks solved together during classes N5. Laboratory – short tests (written/electronic) N6. Laboratory and project – computer and software incl. IDE, VCS

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02	Mid-semester test (written or online)
F2	PEU_W01 PEU_W02	Final test (written or online)
F3	PEU_U01 PEU_U02 PEU_U03 PEU_U04 PEU_K02 PEU_K03	Group project
F4	PEU_U01 PEU_U02 PEU_U03 PEU_U04 PEU_K01	Individual lists of tasks
F5	PEU_U01 PEU_U02 PEU_U03 PEU_U04	Short tests (written or online)
P = (2*F1 + 2*F2 + 4*F3 + 3*F4 + F5) / 12 if Fx >= 3.0 for x in 3..5 else 2.0		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Loubser, Nico. (2021). Software Engineering for Absolute Beginners. Berkeley, CA: Apress L. P.
[2] Foster, E. (2014). Software Engineering. Apress.
[3] Sommerville, I. (2007). Software engineering (8th ed., International Computer Science Series). Harlow: Addison-Wesley.

SECONDARY LITERATURE:

[1] Frederick P. Brooks. (2021). Mythical Man-Month, Anniversary Edition, The: Essays On Software Engineering, Portable Documents. Addison-Wesley Professional.
[2] Green, M. David. (2016). Scrum. Victoria: SitePoint Pty, Limited.
[3] Fowler, Martin. (2018). UML Distilled: A Brief Guide to the Standard Object Modeling Language (The Addison-Wesley object technology series). Pearson Education.
[4] Martin Fowler. (2018). Refactoring: Improving the Design of Existing Code. Addison-Wesley Professional.
[5] Robert C. Martin. (2019). Clean Agile: Back to Basics. Pearson.
[6] Wiegers, K., & Beatty, J. (2013). Software Requirements. Microsoft Press.
[7] Winters, Titus, Manshreck, Tom, & Wright, Hyrum. (2020). Software Engineering at Google. Sebastopol: O'Reilly Media, Incorporated.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr inż. Witold Dyrka (witold.dyrka@pwr.edu.pl)
mgr inż. Mateusz Milian (mateusz.milian@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish METODY NUMERYCZNE
Name of subject in English NUMERICAL METHODS
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	75		75		
Form of crediting	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	3		3		
including number of ECTS points for practical classes (P)			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,28		1,28		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Basic knowledge of programming, physics, linear algebra, and mathematical analysis

SUBJECT OBJECTIVES

C1 Understand the fundamental principles of digital computing, including number representation, and arithmetic operations
C2 Understand modelling of biological and physiological systems with linear algebra and ordinary differential equations

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 understands the linkage between accuracy, stability, and convergence.
PEU_W02 understands the propagation of errors through complex numerical algorithms.
PEU_W03 understands the use of interpolation for numerical differentiation and integration.

relating to skills:

PEU_U01 is able to develop efficient and stable algorithms for finding roots of non-linear equations.
PEU_U02 is able to develop stable algorithms for solving linear systems of equations.
PEU_U03 is able to develop stable solution algorithms for ordinary differential equations.
PEU_U04 can perform numerical simulation of biological phenomena.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Computer architecture number representation	2
Lec 2	Error propagation	2
Lec 3	Root finding	2
Lec 4	Linear system of equations: Cramer's Rule and Gaussian Elimination	2
Lec 5	Pivoting. LU Factorization	2
Lec 6	Tri-diagonal system	2
Lec 7	Linear systems: iterative methods	2
Lec 8	Polynomial and Lagrange Interpolation	2
Lec 9	Numerical integration	2
Lec 10	Numerical differentiation	2
Lec 11	Ordinary differential equations: Runge-Kutta methods	2
Lec 12	Neuronal activity modelling	2
Lec 13	Molecular dynamics simulation I	2
Lec 14	Molecular dynamics simulation II	2
Lec 15	Final test	2
	Total hours	30

	Laboratory	**Number of hours**
Lab 1	Approximation and round-off errors	2
Lab 2	Truncation errors and the Taylor series	2
Lab 3	Root finding	2
Lab 4	Gauss Elimination	2
Lab 5	LU decomposition	2
Lab 6	Special matrices	2
Lab 7	Midterm test	2
Lab 8	Interpolation	2
Lab 9	Numerical integration (Newton-Cotes integration formulas)	2
Lab 10	Numerical differentiation	2

Lab 11	Initial value problem: Euler methods	2
Lab 12	Runge-Kutta methods	2
Lab 13, 14	Term project	4
Lab 15	Final test	2
	Total hours	30

TEACHING TOOLS USED
N1. Traditional lecture N2. Computer laboratory – solving tasks N3. Lab reports N4. Consultations N5. Self-study N6. Digital resources (ePortal PWr) N7. Quizzes

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02 PEU_W03	Final test
F2	PEU_U01 PEU_U02 PEU_U03 PEU_U04	Lab reports
F3	PEU_U01 PEU_U02 PEU_U03 PEU_U04	Quizzes
F4	PEU_U01 PEU_U02 PEU_U03 PEU_U04	Project
P = F1 (final test on lecture) P = weighted average of F2-F4 (laboratory)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Chapra S., Canale, R., Numerical Methods For Engineers, 2020
[2] Gezerlis A., Numerical Methods in Physics with Python, 2020

SECONDARY LITERATURE:

[1] Lutz M., Learning Python (5th Edition), 2013
[2] Matthes E., Python Crash Course, 2nd Edition: A Hands-On, Project-Based Introduction to Programming, 2019

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr hab. inż. Mirosław Łątka (miroslaw.latka@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish SYSTEMY POMIAROWE
Name of subject in English MEASUREMENT SYSTEMS
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes at the University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	50		50		
Form of crediting	~~Examination~~ / crediting with grade*		~~Examination~~ / crediting with grade*		
For group of courses mark (X) final course					
Number of ECTS points	2		2		
including number of ECTS points for practical classes (P)			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,28		1,28		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of electronics and electrical engineering
2. Basic knowledge of microcontroller structure and components

SUBJECT OBJECTIVES

C1 Acquisition of knowledge in the field of structure, properties, application areas and software of measurement systems in biomedical applications.
C2 Acquisition of skills in the transmission, acquisition, and processing of measurement data.
C3 Acquisition of skills in the programming of virtual instruments and measurement systems using a graphical programming environment.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 has knowledge of the structure, properties, and applications of biomedical measurement systems and basic knowledge of wired and wireless interfaces and protocols used in measurement systems.

relating to skills:

PEU_U01 is able to select and communicate the elements of a measurement system, develop an algorithm to realize the measurement task and create software for virtual measurement instrument.

relating to social competences:

PEU_K01 develops competencies in team collaboration and in improving methods of developing a strategy to solve the task assigned to the group.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Basic concepts, structure and tasks of measurement systems, categories of measurement systems	2
Lec 2	Introduction to digital communication and communication interfaces in measurement systems, configurations (topologies), possibilities and practical examples	2
Lec 3	Communication interfaces RS232, UART, USB (CDC and HID): parameters, the physical layer, data transmission organization, design, transceivers, application examples - part one	2
Lec 4	Communication interfaces RS232, UART, USB (CDC and HID): parameters, the physical layer, data transmission organization, design, transceivers, application examples - part two	2
Lec 5	Methods of increasing distance and number of nodes in measurement systems using wired communication, application of current loop, RS485 standard, transceivers, examples of implementation	2
Lec 6	Introduction to virtual instrumentation programming, introduction to LabView environment, program organization and development of user interface Programming structures and data types in LabView environment, data flow control	2
Lec 7	Data flow analysis in Labview environment and debugging. Serial interfaces handling using VISA API and device drivers in LabView package. Examples of implementing measurement tasks in the LabView environment using a multimeter with a serial interface and a measurement card.	2
Lec 8	Analog-to-digital processing methods in measurement cards and modules, Analog-Front-End measurement modules	2
Lec 9	Measuring and control cards, real-time measurement systems, configuration of modular systems	2
Lec 10	1-wire interface and Microlan networks, the physical aspect, addressing, identification of new devices, application areas and implementation examples	2
Lec 11	SPI and I2C/TWI local interfaces, microcontroller communication with peripheral systems in measurement systems, parameters, configuration, examples of measurement applications (part one)	2

Lec 12	SPI and I2C/TWI local interfaces, microcontroller communication with peripheral systems in measurement systems, parameters, configuration, examples of measurement applications (part two)	2
Lec 13	Measurement systems in mobile telecommunication networks, operation of GSM/UMTS, SMS, modem modules, AT commands, parameters and selection of the module and antenna, examples of applications in measurement systems with remote wireless access	2
Lec 14	Wireless measurement systems in ZigBee networks, functions of network nodes, topologies, network self-organization, energy reduction and "energy harvesting", electronic modules, application examples	2
Lec 15	Bluetooth wireless measurement systems, network organization, profiles, BT Low Energy	2
	Total hours	30

Laboratory		**Number of hours**
Intro	Introductory class: • basics of programming in LabView • learning the principles of operator interface development • acquiring skills of using basic methods of data presentation • implementation of a sample application	2
Lab 1	Exercise 1 - Signal Generator. Exercise objectives: Practical application of the knowledge gained during the introductory classes and the lecture. The student acquires the ability to perform basic tasks and implement algorithms used in the development of virtual devices using the LabView environment.	4
Lab 2	Exercise 2 - Operation of measuring devices with serial interface (VISA API). Exercise objectives: Getting familiar with the methods of operating devices with a serial interface and implementation of the virtual device using multimeters. Getting familiar with methods of creating own modules (subVI) in LabView environment.	6
Lab 3	Exercise 3 - Virtual control and measurement device using a measurement card. Exercise objectives: To become familiar with the methods of handling measurement cards using dedicated drivers and functions Ability to implement the control and measurement device with the use of external measurement card Acquaintance with data export methods and two-dimensional results presentation	6
Lab 4	Exercise 4 - Patient fall detector using accelerometer with I2C interface. Exercise objectives: To develop a virtual measurement device that performs the function of a patient fall detector Acquiring skills of handling measurement transducers using digital local interfaces through the use of an accelerometer transducer equipped with an I2C interface.	6
Lab 5	Exercise 5 - Remote Measurement. Exercise objectives: Getting acquainted with methods of data transmission organization in measuring systems. Developing communication protocol for measuring devices working in single-master/multi-slave configuration and applying the developed protocol to perform remote measurements.	6

	Total hours	30

TEACHING TOOLS USED
N1. Multimedia lecture N2. Datasheets and application notes of manufacturers of electronic circuits and devices N3. Laboratory demonstrations N4. Experimental (laboratory) work with measurement cards, sensors, and multimeters (with communication interface) N5. Software work

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
Laboratory		
F1	PEU_U01 PEU_K01	List of tasks, tasks completed in groups of two and settled individually by awarding points according to the scoring described in the introduction to the exercise. Credit is given by presenting a diagram of the completed assignment, discussing, and demonstrating how it works, and individually answering questions from the instructor. Tasks include programming, hardware configuration and implementation of functioning measurement systems and virtual instruments.
P1	PEU_U01	The final grade is based on the total number of points earned by the student for each task. To receive a positive final grade, the student must obtain at least 50% of the points for each task.
Lecture		
P3	PEU_W01	Written exam with open and closed questions. The instructor provides the material presented in lecture and a list of exam questions.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Manuals, standards and application notes (references provided in lecture)
[2] Measurement and Instrumentation: Theory and Application, Alan S. Morris, Reza Langari, 2020
[3] Doebelin's Measurement Systems, Ernest O. Doebelin, Dhanesh N. Manik, 2019

SECONDARY LITERATURE:

[1] Hands-On Introduction to LabVIEW for Scientists and Engineers, John Essick, 2018
[2] LabVIEW Graphical Programming, Fifth Edition, Jennings Richard, 2019
[3] Modern Digital And Analog Communication Systems, B. P. Lathi, Zhi Ding

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr inż. Tomasz Grysiński (tomasz.grysinski@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish GRAFIKA KOMPUTEROWA
Name of subject in English COMPUTER GRAPHICS
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: ~~obligatory~~ / optional / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	75		75		
Form of crediting	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	3		3		
including number of ECTS points for practical classes (P)			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,28		1,28		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Knowledge of Algebra

SUBJECT OBJECTIVES

C1 Becoming familiar with fundamental concepts of computer graphics

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 knows the basic concepts of computer graphics (viewing, projection, perspective, modelling and transformation in two and three dimensions.
PEU_W02 can describe the fundamentals of animation, parametric curves, surfaces, and spotlighting.

relating to skills:
PEU_U01 is able to solve graphics programming issues, including 3D transformation, objects modelling, color modelling, lighting, textures, and ray tracing.
PEU_U02 is able to identify a typical graphics pipeline and apply graphics programming techniques to design and create computer graphics.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Introduction to Computer Graphics	2
Lec 2	Graphics Systems	2
Lec 3	Primitives and attributes	2
Lec 4	2D Geometric Transformations	2
Lec 5	3D Geometric Transformations	2
Lec 6	2D Viewing	2
Lec 7	Graphical User Interface	2
Lec 8-12	OpenGL	10
Lec 13	Basic Ray Tracing Algorithms	2
Lec 14	Application of Computer Graphics in Biomedical Engineering	2
Lec 15	Final test	2
	Total hours	30

Laboratory		**Number of hours**
Lab 1	Introduction to Computer Graphics	2
Lab 2	Graphics Systems	2
Lab 3	Primitives and attributes	2
Lab 4	2D Geometric Transformations	2
Lab 5	3D Geometric Transformations	2
Lab 6	2D Viewing	2
Lab 7	Graphical User Interface	2
Lab 8-12	OpenGL	10
Lab 13	Basic Ray Tracing Algorithms	2
Lab 14-15	Project development	4
	Total hours	30

TEACHING TOOLS USED
N1. Traditional lecture N2. Computer laboratory – solving tasks N3. Lab reports N4. Consultations N5. Self-study N6. Digital resources (ePortal PWr) N7. Quizzes

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02	Final test
F2	PEU_U01 PEU_U02	Lab reports
F3	PEU_U01 PEU_U02	Quizzes
F4	PEU_U01 PEU_U02	Project
P = F1 (final test on lecture) P = weighted average of F2-F4 (laboratory)		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Gambetta, G., Computer Graphics from Scratch: A Programmer's Introduction to 3D Rendering, No Starch Press, 2021 [2] Shirley, P., Marschner, S., Fundamentals of Computer Graphics, G, 2018 [3] Akenine-Möller, T., Hoffman, N., Real-Time Rendering, Fourth Edition (4th Edition), A K Peters/CRC Press, 2018 **SECONDARY LITERATURE:** [1] Scientific publications

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
dr hab. inż. Mirosław Łątka (miroslaw.latka@pwr.edu.pl) dr inż. Klaudia Kozłowska (klaudia.kozlowska@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish PROGRAMOWANIE WIELOPLATFORMOWYCH APLIKACJI MOBILNYCH

Name of subject in English CROSS-PLATFORM MOBILE APPLICATION DEVELOPMENT

Main field of study (if applicable): BIOMEDICAL ENGINEERING

Specialization (if applicable): MEDICAL INFORMATICS

Profile: academic / ~~practical~~*

Level and form of studies: 1st/ ~~2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*

Kind of subject: ~~obligatory~~ / optional / ~~university-wide~~*

Subject code …….

Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)				45	
Number of hours of total student workload (CNPS)				100	
Form of crediting	Examination / ~~crediting with grade~~*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points				4	
including number of ECTS points for practical classes (P)				4	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)				1,88	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

It is required to pass the following course: Mobile Application Development.

SUBJECT OBJECTIVES

C1 Introduction to programming in Dart language (Flutter software) for cross-platform software development

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 knows the principles of programming in Dart.

relating to skills:
PEU_U01 can run applications on different devices.
PEU_U02 can implement mobile apps which make use of Internet communication protocols, device features, and databases.
PEU_U03 can implement Mobile Health apps.

PROGRAMME CONTENT

Project		**Number of hours**
Proj 1-5	Flutter and Dart fundamentals	15
Proj 6-10	Project 1	15
Proj 11-15	Project 2	15
	Total hours	45

TEACHING TOOLS USED

N1. Solving simple Flutter tasks
N2. Consultations
N3. Self-study
N4. Digital resources (ePortal PWr)

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_U01 PEU_U02 PEU_U03	Project 1
F2	PEU_W01 PEU_U01 PEU_U02 PEU_U03	Project 2
P = weighted average of F1 and F2 (project)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Bailey T., Biessek A., Flutter for Beginners: An introductory guide to building cross-platform mobile applications with Flutter 2.5 and Dart, 2021
[2] Flutter documentation (https://docs.flutter.dev)
[3] Alessandria S., Kayfitz B., Flutter Cookbook: Over 100 proven techniques and solutions for app development with Flutter 2.2 and Dart, 2021

SECONDARY LITERATURE:

[1] Burd B., Flutter for dummies, 2020

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr hab. inż. Mirosław Łątka (miroslaw.latka@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish ELEMENTY DYNAMIKI NIELINIOWEJ
Name of subject in English ELEMENTS OF NONLINEAR DYNAMICS
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: ~~obligatory~~ / optional / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	75		75		
Form of crediting	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	3		3		
including number of ECTS points for practical classes (P)			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,28		1,28		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Knowledge of mathematical analysis and general physics on the level of first-degree studies in technical sciences

SUBJECT OBJECTIVES

C1 Becoming familiar with basic concepts of nonlinear dynamics: flows, fixed points, linear stability analysis, phase portraits, limit cycles, bifurcations, chaos, strange attractors, Lyapunov exponent.
C2 Becoming familiar with important equations leading to nonlinear behavior
C3 Becoming familiar with modeling of nonlinear phenomena with Computer Algebra System

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 to acquire knowledge related to basic concepts of nonlinear dynamics
PEU_W02 to acquire knowledge related to construction of models of nonlinear dynamics
PEU_W03 become familiar with important models leading to nonlinear dynamical behavior

relating to skills:
PEU_U01 developing basic skills to model nonlinear dynamics phenomena with Maple
PEU_U02 developing skills to use existing Maple worksheets to analyze nonlinear effects in physical, chemical, and biological systems

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Nonlinear systems – an overview (models and diagnostics tools)	4
Lec 2	Phase plane portraits: autonomous system of first-order ODE's, examples of fixed points	4
Lec 3	Phase plane analysis: Simple fixe points and their classification. Geometric interpretation. Higher order fixed points	4
Lec 4	Lorenz's model	4
Lec 5	The period-doubling route to chaos: Duffing's equation	4
Lec 6	One-dimensional maps and Liapunov exponent	4
Lec 7	Approximate analytic methods for nonlinear harmonic oscillators (Poisson's and Lindstedt's perturbation methods)	4
Lec 8	Final test	2
	Total hours	15

Laboratory		**Number of hours**
Lab 1-2	Computer algebra systems: equations, plotting, elements of linear algebra, basic mathematical analysis, ordinary differential equations	4
Lab 3-4	Phase-plane portraits and analysis (stationary points, "famous" phase portraits)	4
Lab 5-6	Linear and nonlinear oscillators	4
Lab 7-8	Deterministic chaos and Poincare section	4
Lab 8-9	Logistic map	4
Lab 10-11	Reconstructing an attractor	4
Lab 12-14	Physiological data analysis (project)	4
Lab 15	Project presentation	2
	Total hours	30

TEACHING TOOLS USED

N1. Lecture with multimedia presentation
N2. Computer laboratory – Computer Algebra System Maple

N3. Digital resources N4. Consultations

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEK_W01 PEK_W02 PEU_W01	oral tests, discussions, progress check in computer lab
F2	PEU_U01 PEU_U02 PEK_K01	crediting with grade (lecture), crediting with grade (computer lab)
P = (F1+F2)/2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] J. A.C. Mitus, Nonlinear Dynamics – Lecture Notes (teaching materials for BDA students)
[2] A.C. Mitus, Nonlinear Dynamics - Computer Lab Projects (teaching materials for BDA students)
[3] S.H. Strogatz, Nonlinear Dynamics and Chaos, Perseus Books, 1994.
[4] R.H. Enns, G.C. McGuire, Nonlinear Physics with Maple for Scientists and Engineers, Birkhauser, 2000.
[5] A.C. Mitus, R. Orlik, G. Pawlik, Wstęp do pakietu algebry komputerowej Maple, Polkowice, 2010 (in polish)

SECONDARY LITERATURE:

[1] R.H. Enns, G.C. McGuire, Computer Algebra Recipes. An Advanced Giude to Scientific Modeling, Birkhauser, 2007.
[2] R.H. Enns, Computer Algebra Recipes for Mathematical Physics, Birkhauser, 2005.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

prof. dr hab. Antoni C. Mituś (antoni.mitus@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish MODELOWANIE UKŁADÓW BIOLOGICZNYCH
Name of subject in English MODELLING OF BIOLOGICAL SYSTEMS
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30	15	
Number of hours of total student workload (CNPS)	75		75	50	
Form of crediting	Examination / ~~crediting with grade~~*	Examination / crediting with grade*	~~Examination /~~ crediting with grade*	~~Examination /~~ crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	3		3	2	
including number of ECTS points for practical classes (P)			3	2	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,44		1,28	0,68	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Mathematical Analysis
2. Algebra and Analytic Geometry
3. Informatics
4. Biochemistry
5. Biophysics
6. Introduction to Physiology

SUBJECT OBJECTIVES

C1 Learning to model selected issues in the field of biology and to analyze the relationship between the applied biological quantities

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 can correctly and effectively use the previously known programming tools to analyze the presented models of biological processes.

PEK_W02 is able to model selected biological phenomena based on the literature values of the parameters of a given process.

relating to skills:

PEK_U01 can correctly and effectively apply the learned principles and laws of physics and biochemistry to the qualitative and quantitative analysis of practical engineering issues in the field of biomedical engineering

PEK_U02 can correct and efficiently solve simple biophysical, physiological or biomedical problems. Can correctly interpret the results obtained during the experiment and assess their credibility relating to social competences.

relating to social competences:

PEK_K01 is able to work in a team, is aware of taking responsibility for jointly performed tasks.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Modeling and control in physiology	2
Lec 2	Dialysis	2
Lec 3-4	Cholesterol homeostasis	4
Lec 5	Gallbladder motility	2
Lec 6	Gallstone formation	2
Lec 7	Modeling the pulse wave in arterial vessels	2
Lec 8	Modeling the transport of water and substances in tissues	2
Lec 9	Model of cancer-immune ststem	2
Lec 10	Modeling carbohydrate metabolism	2
Lec 11	Pharmacokinetics of drugs	2
Lec 12	Basic epidemiological model (SIR)	2
Lec 13-14	Epidemiological model with the age structure of the population (SEIRD)	4
Lec 15	Final test	2
	Total hours	30
Laboratory		**Number of hours**
Lab 1	Analysis of dialysis proces	2
Lab 2	Construction of multiparameter model of pharmacokinetics of drugs	2
Lab 3	Searching for the optimal solution of multiparameter model	2
Lab 4	Construction of a model of cholesterol homeostasis	2
Lab 5	Analysis of model sensitivity to changes in parameter values	2
Lab 6	Construction of model of gallbladder motility	2
Lab 7	Analysis of the risk of gallstone formation	2

Lab 8	Solution basic epidemiological model (SIR) – analysis of model parameters	2
Lab 9	Construction of a model with several disease waves	2
Lab 10	Construction of a model taking into account vaccinations	2
Lab 11	Solution of SEIRD model	2
Lab 12	Analysis of the influence of the age structure and contacts between age groups on the course of a pandemic	2
Lab 13	Search for the optimal vaccination strategy	2
Lab 14	Presentation of student projects	2
Lab 15	Presentation of student projects	2
	Total hours	30

Project		**Number of hours**
Proj 1	Introduction	1
Proj 2-5	Project 1 (cholesterol homeostasis)	6
Proj 6-8	Project 2 (SEIRD)	8
	Total hours	15

TEACHING TOOLS USED

N1. Multimedia lecture
N2. Computers + multimedia projector
N3. Computer (Matlab, Python)

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEK_W01 PEK_U01 PEK_U02	Lab reports (laboratory)
F2	PEK_U01 PEK_U02 PEK_K01	Project 1 (project)
F3	PEK_U01 PEK_U02 PEK_K01	Project 2 (project)
P	PEK_W01 PEK_W02	Final test (lecture)

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] J.D. Murray, in: Mathematical Biology: I. An Introduction, third ed., Springer, 1993. Interdisciplinary Applied Mathematics.
[2] Ching Shan Chou, Avner Friedman, Introduction to Mathematical Biology, Springer International Publishing 2016.
[3] Control therory in Biomedical Engineering. Applications in Physiology and medical robotics, Ed. Olfa Boubaker, Elsevier, 2020
[4] Inżynieria Biomedyczna Podstawy i Zastosowania. Tom 1 Modelowanie procesów fizjologicznych i patofizjologicznych, red. K. Cieślicki, T. Lipniacki, J. Waniewski, Akademicka Oficyna Wydawnicza Exit, 2017

SECONDARY LITERATURE:

[1] K. Kubica, J. Balbus, Mathematical modeling of cholesterol homeostasis in Control Theory in Biomedical Engineering, Applications in Physiology and Medical Robotics (Ed. O. Boubaker) Academic Press, 2020, s. 43-61, 359-365, ISBN: 978-0-12-821350-6

[2] M. Żulpo, J. Balbus, P. Kuropka, K. Kubica, A model of gallbladder motility, Computers in Biology and Medicine 93(2018) 139-148, doi.org/10.1016/j.compbiomed.2017.12.018

[3] K. Buszko, K. Kubica, E. Luisehobl, P. Adamski, K. Wnuk, B. Jilma, J. Kubica, Pharmacokinetic modeling of morphine's effect on plasma concentrations of ticagrelor and its metabolite in healthy volunteers. Frontiers in Physiology, section Computational Physiology and Medicine, 2021, 12, DOI: 10.3389/fphys.2021.663170

[4] K. Kubica, J. Balbus, A computer study of the risk of cholesterol gallstone associated with obesity and normal weight, Scientific Reports (2021) 11:8868, doi.org/10.1038/s41598-021-88249-w

[5] Ryosuke Omori, Ryota Matsuyama, Yukihiko Nakata, The age distribution of mortality from novel coronavirus disease (COVID 19) suggests no large diference of susceptibility by age, Scientific Reports (2020) 10:16642, doi.org/10.1038/s41598-020-73777-8

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

prof. dr hab. Krystian Kubica (krystian.kubica@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish KONWERSJA I ANALIZA SYGNAŁÓW NIEELEKTRYCZNYCH
Name of subject in English CONVERSION AND ANALYSIS OF NON-ELECTRICAL SIGNALS
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	50		50		
Form of crediting	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	2		2		
including number of ECTS points for practical classes (P)			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,28		1,28		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Basic knowledge of physics and mathematics.

SUBJECT OBJECTIVES

C1 Knowing and understanding the conversion of non-electric signals to electric.
C2 Gaining knowledge about the use of signal conversion in medicine.
C3 Experimental data analysis.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 knows the correct concepts for the conversion of non-electrical signals.

PEU_W02 has knowledge of the phenomena and methods used to convert and collect non-electric signals.

relating to skills:

PEU_U01 can identify and describe the most important processes for the conversion of non-electrical signals.

PEU_U02 can plan or select an experiment in order to convert non-electrical signals used in medicine.

relating to social competences:

PEU_K01 understands the need for continuous training, including self-education; knows and understands the need to learn independently and in a group.

PEU_K02 can work independently and in a group.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Basic information on signal conversion	2
Lec 2	Dynamic properties of sensors	2
Lec 3	Capacitance methods of elongation measurements used in medicine. The principle of capacitance sensors	2
Lec 4	Basics of piezoelectric sensors. Applications of piezoelectric sensors in medicine	2
Lec 5	Usage of magnetic fields to store and retrieve information	2
Lec 6	Thermoelectric effect and materials	2
Lec 7	Non-contact methods of temperature measurement.	2
Lec 8	Contact methods of temperature measurement	2
Lec 9	Impedance methods of drug investigations	2
Lec 10	Optical methods of signal conversion	2
Lec 11	Measurements of motion parameters and their analysis	2
Lec 12	Methods of measuring mechanical stress, force, and torque	2
Lec 13	Pressure measurements and sensors	2
Lec 14	Measurements of volumetric and mass flow rate in liquids and gasses	2
Lec 15	Test	2
	Total hours	30

	Laboratory	**Number of hours**
Lab 1	Introduction, rules for passing a course	2
Lab 2	Temperature sensors	2
Lab 3	Measurements in dynamic conditions	2
Lab 4	Sensors for pressure measurements	2
Lab 5	Measurements of the gases flow rate	2
Lab 6	Examination of the arterial pressure sensor	2
Lab 7	Measurements of the liquids flow rate	2

Lab 8	Capacitance sensors and transducers	2
Lab 9	Piezoelectric sensors and transducers	2
Lab 10	Infrared sensors	2
Lab 11	Hall effect sensors	2
Lab 12	Thermoelectric generator	2
Lab 13	Electro-optic modulator	2
Lab 14	Displacements sensors	2
Lab 15	Students' individual repetition and course completion	2
	Total hours	30

TEACHING TOOLS USED

N1. Multimedia lecture
N2. Materials posted on e-portal.pwr.edu.pl (data sheets of device manufacturers, instructions on laboratory)
N3. Equipment in the laboratory
N4. Consultations

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02 PEU_U01 PEU_K01	Final test
F2	PEU_U01 PEU_U02 PEU_K01 PEU_K02	Test during laboratory Reports on lab experiments
P = F1 lecture – assessment based on the final test P = F2 laboratory – assessment based on the average of the tests and reports		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Handbook of Modern Sensors: Physics, Designs, and Applications, J. Fraden, Springer 2016
[2] Foundations and Applications of Sensor Management A.O. Hero, D. Castañón, D. Cochran, K. Kastella, Springer 2008

SECONDARY LITERATURE:

[1] Lines M. E., Glass A. M., Principles and application of ferroelectrics and related materials, Claredon Press, Oxford 1977
[2] Noltingk B.E., Instrumentation reference book, Butterworth-Heinemann, Londyn 1995
[3] Regtien P.P.L., Measurement science for engineers, Kogan Page Science, London 2004

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr hab. inż. Adam Sieradzki (Adam.Sieradzki@pwr.edu.pl)
dr inż. Elżbieta Szul-Pietrzak (Elzbieta.Szul-Pietrzak@pwr.edu.pl)
dr inż. Mateusz Popek (mateusz.popek@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish TECHNIKI OBRAZOWANIA MEDYCZNEGO
Name of subject in English MEDICAL IMAGING TECHNIQUES
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			30	
Number of hours of total student workload (CNPS)	25			50	
Form of crediting	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	1			2	
including number of ECTS points for practical classes (P)				2	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,68			1,28	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of biophysics
2. Knowledge of physics
3. Basic knowledge of anatomy and physiology

SUBJECT OBJECTIVES

C1 Obtain basic knowledge of medical imaging techniques
C2 Acquire knowledge of the construction and operation of diagnostic devices used for medical imaging
C3 Presentation of the possibilities of using techniques of imaging in medicine and physiotherapy

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 has basic general knowledge of medical imaging techniques.

PEU_W02 has ordered, theoretically based general knowledge of the most important scientific fields of Biomedical Engineering, in particular medical imaging.

PEU_W03 knows and understands the basic concepts and principles in the field of industrial property; is able to use patent information resources in the field of Biomedical Engineering.

relating to skills:

PEU_U01 is able to prepare well documented written elaborations on problems in the field of Biomedical Engineering, in particular medical imaging, in Polish or other foreign language used in international communications.

PEU_U02 Is able to prepare and present an oral presentation in Polish and a foreign language concerning the use of medical imaging techniques in diagnostics and therapy in medicine

PEU_U03 Can make a preliminary economic analysis of undertaken engineering activities in the field of biomedical engineering

relating to skills:

PEU_K01 can think and act in a creative way.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Introduction. Medical imaging.	2
Lec 2	The application of microscopic techniques for medical imaging (Atomic Force Microscopy (AFM) and Transmission Electron Microscopy (TEM)). Construction of a microscope, operation, application in medicine and biomedical engineering.	2
Lec 3	Ultrasonography. Construction of the equipment, operation, application in medicine and biomedical engineering.	2
Lec 4	Radiology. Construction of the apparatus, operation, application in medicine and biomedical engineering.	2
Lec 5	Computed tomography. Construction of the equipment, operation, application in medicine and biomedical engineering.	2
Lec 6	Magnetic resonance. Construction of the apparatus, operation, application in medicine and biomedical engineering.	2
Lec 7	Nuclear medicine. PET and hybrid techniques. Construction of the apparatus, operation, application in medicine and biomedical engineering.	2
Lec 8	Nuclear medicine. SPECT and hybrid techniques. Construction of the apparatus, operation, application in medicine and biomedical engineering.	2
	Total hours	15

Project		**Number of hours**
Proj 1-15	The task of the student will be to design a method of examination using medical imaging techniques. The research will concern the diagnosis and therapy of disease entities using medical imaging methods. The defense of the project will consist in	2

	the preparation of a multimedia presentation by each student, during which the student will present methods of research and analysis of the results of the research carried out. The project will cover all stages of research (from laboratory tests, through in vitro, to in vivo) related to solving a given medical problem. The project will end with a proposal to implement a given solution and a detailed cost estimate.	
	Total hours	30

TEACHING TOOLS USED
N1. Lecture – multimedia presentation N2. Written elaboration of the paper N3. Multimedia presentation with disscusion - project

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02 PEU_U01	Crediting with grade
F2	PEU_W03 PEU_U02 PEU_U03 PEU_K01	Rating of prepared project
P1 – crediting with grade P2 – rating of prepared project		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] 3D images of materials structures: processing and analysis. Joachim Ohser and Katja Schladitz. Weinheim: Wiley-VCH Verlag GmbH & Co. KGaA, cop. 2009
[2] Biocybernetyka i inżynieria biomedyczna 2000. Red. M. Nałęcz**.** Tom 8. Obrazowanie Biomedyczne. Red. L. Chmielewski, J.L. Kulikowski, A. Nowakowski. Współpraca: Polskie Towarzystwo Przetwarzania Obrazów. Akademicka Oficyna Wydawnicza EXIT, Warszawa 2001.
[3] Gotszalk T.P., Systemy mikroskopii bliskich oddziaływań w badaniach mikro- i nanostruktur. Ofic. Wyd. PWr, Wrocław 2004.
[4] Kopaczyńska M., Mikroskopia sił atomowych (AFM) - biomedyczne zastosowanie pomiarów w nanoskali. Ofic. Wyd. PWr, Wrocław 2010.
[5] Optical imaging techniques in cell biology. Guy Cox. Boca Raton: CRC/Taylor & Francis, cop. 2007.
[6] Watt I.M., The principles and practice of electron microscopy, Cambridge University Press, Cambridge, 2003.

SECONDARY LITERATURE:

[1] Articles from the journals: Molecular imaging, Biomechanics and Modeling in Nanotechnology, Molecular imaging and Biology, Real-time imaging, Biomolecular Engineering, Bioscience, Contrast media and molecular imaging, Biomaterials

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr hab. Marta Kopaczyńska (marta.kopaczynska@pwr.wroc.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish REDAGOWANIE TEKSTÓW NAUKOWYCH
Name of subject in English ACADEMIC WRITING
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)			30		
Number of hours of total student workload (CNPS)			25		
Form of crediting	Examination / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points			1		
including number of ECTS points for practical classes (P)			1		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)			0,68		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Knowledge of MS Office

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SUBJECT OBJECTIVES

C1 Acquiring technical skills related to writing and editing scientific works
C2 Ability to search for scientific literature and knowledge of the rules of using source materials

SUBJECT EDUCATIONAL EFFECTS

relating to skills:

PEU_U01 has the ability to self-study, is able to independently plan his own lifelong learning.

PEU_U02 has language skills in the field of technical sciences and scientific discipline Biomedical engineering, can search and correctly cite professional literature in the text.

PEU_U03 is able to plan and organize work individually and in a team.

PEU_U04 is able to prepare a scientific text.

relating to social competences:

PEU_K01 is aware of the social role of a technical university graduate, in particular understands the need to formulate and provide information to the public about technological progress and other aspects of engineering activities.

PROGRAMME CONTENT

	Project	**Number of hours**
Lab 1	Course overview. Requirements and evaluation of the subject learning outcomes. Introduction to writing a scientific works	2
Lab 2	Planning and writing – structure of the scientific works	2
Lab 3	General writing resources, editing tools and rules, visual presentation of the scientific data	2
Lab 4	High quality bibliography – sources, citations' style guide overview and formatting, citation rules. Avoiding plagiarism	2
Lab 5	Professional text editing	2
Lab 6	Thesis prewriting: setting goals, plan, getting started	2
Lab 7	Thesis intensive writing: literature survey, first draft	2
Lab 8	Thesis intensive writing: revising	2
Lab 9	Thesis intensive writing: redrafting	2
Lab 10	Thesis intensive writing: project' proofreading, final editing and submitting	
Lab 11	Preparation of the thesis presentation	
Lab 12	Public speaking and presenting – individual presentations of the project	2
Lab 13	Public speaking and presenting – individual presentations of the project	2
Lab 14	Projects individual discussion and evaluation.	2
Lab 15	Supplementary classes. Issuing the final grades	2
	Total hours	30

TEACHING TOOLS USED

N1. Bord, computer, projector

N2. Self-study

N3. Individual consultations

N4. Digital resources (WUST Main Library, WUST ePortal, Internet)

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F	PEU_U01 PEU_U02 PEU_U03 PEU_U04 PEU_K01	Assessment of the individual parts of the project
P – weighted average of the grades		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Charles Lipson, How to Write a BA Thesis - A Practical Guide from Your First Ideas to Your Finished Paper, The University of Chicago Press, Chicago, 2nd edition, 2018

[2] David Evans, Paul Gruba, Justin Zobel, How to Write a Better Thesis, Springer International Publishing, 3rd edition, 2014

[3] Umberto Eco, How to Write a Thesis, MIT Press, 2015

[4] Purdue University, Purdue Online Writing Lab OWL®, available on-line: https://owl.purdue.edu/owl/graduate_writing/thesis_and_dissertation/getting_started.html

[5] University of Oxford, Plagiarism, available on-line: https://www.ox.ac.uk/students/academic/guidance/skills/plagiarism

[6] Chris A. Mack, How to write a good scientific paper, SPIE, 2018, available on-line: https://spie.org/samples/9781510619142.pdf

[7] Angel Borja, 11 steps to structuring a science paper editor will take seriously, Elsevier, 2014, available on-line: https://www.elsevier.com/connect/11-steps-to-structuring-a-science-paper-editors-will-take-seriously

SECONDARY LITERATURE:

[1] Compilation Inc. An effective bibliography: great but how? Available on: https://www.compilatio.net/en/blog/effective-bibliography

[2] Joshua Schimel, Writing Science – How to write papers that get cited and proposals that get funded, Oxford University Press Inc, 2011

[3] Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams, Joseph Bizup, William T. Fitzgerald, The Craft of Research, The University of Chicago Press, Chicago, 4th edition, 2016

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr inż. Joanna Bauer (joanna.bauer@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish METODY STATYSTYCZNE W BIOINŻYNIERII
Name of subject in English STATISTICAL METHODS IN BIOENGINEERING
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: ~~obligatory~~ / optional / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)			30		
Number of hours of total student workload (CNPS)			75		
Form of crediting	Examination / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points			3		
including number of ECTS points for practical classes (P)			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)			1,28		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Basic knowledge of statistics and probability

SUBJECT OBJECTIVES

C1 Acquiring knowledge about the statistical methods used in bioengineering, biomedicine, and medicine
C2. Gaining skills in applying basic statistical methods

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 knows and understands to the principles of a selected series of statistical tests.
PEU_W02 knows and understands to the advantages, disadvantages and limitations of select statistical tests.
PEU_W03 has knowledge how to use the statistical tests in biomedical engineering.

relating to skills:
PEU_U01 can obtain basic information on statistical methods from literature, databases, and other sources.
PEU_U02 can interpret the results and draw conclusions based on the results of selected statistical tests.
PEU_U03 can use information techniques to implement basic statistical methods.

PROGRAMME CONTENT

	Laboratory	**Number of hours**
Lab 1	Introduction	2
Lab 2	T tests for dependent and independent variables	2
Lab 3	Mann-Whitney test	2
Lab 4	Wilcoxon test and sign test	2
Lab 5	Univariate Anova	2
Lab 6	Multivariate Anova	2
Lab 7	Anova with repeated measures	2
Lab 8	Midterm exam 1	2
Lab 9	Kruskal-Wallis test	2
Lab 10	Friedman test	2
Lab 11	Correlation analysis (parametric, non-parametric and partial)	2
Lab 12	Linear regression analysis	2
Lab 13	Linearized regression analysis	2
Lab 14	Logistic regression analysis	2
Lab 15	Midterm exam 2	2
	Total hours	30

TEACHING TOOLS USED

N1 The blackboard and the marker as a teaching aid during the laboratory
N2 Computer and software (Statistica, Matlab, Excel)

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02 PEU_W03 PEU_U01 PEU_U02 PEU_U03	Written test 1
F2	PEU_W01 PEU_W02 PEU_W03	Written test 2

	PEU_U01 PEU_U02 PEU_U03	
C = max[mean(F1, F2);median(F1,F2)]		

PRIMAY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Deborah J. Rumsey 2019 Statistics Essentials For Dummies 1st Edition, Wiley Andrzej Stanisz, Przystępny kurs statystyki z zastosowaniem STATISTICA PL na przykładach z medycyny, tom 1, 2, 3 Wydawca: StatSoft Polska, Kraków, 2006

[2] Michael J. Campbell, David Machin, Stephen J. Walters, Medical Statistics: A Textbook for the Health Sciences (Medical Statistics), John Wiley & Sons, 2010

SECONDARY LITERATURE:

[1] Field, Andy. 2013. Discovering Statistics Using IBM SPSS Statistics. 4th ed. London, England: SAGE Publications.

[2] DeMaris, Alfred; Selman, Steven H 2013. Converting Data into Evidence: A Statistics Primer for the Medical Practitioner. New York, NY: Springer New York

[3] Belinda Barton, Jennifer Peat 2014 Medical Statistics: A Guide to SPSS, Data Analysis and Critical Appraisal, 2nd Edition, Wiley

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr hab. inż. Magdalena Kasprowicz (magdalena.kasprowicz@pwr.edu.pl)
dr inż. Agnieszka Uryga (agnieszka.uryga@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish SZTUCZNA INTELIGENCJA 1
Name of subject in English ARTIFICAL INTELLIGENCE 1
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: ~~obligatory~~ / optional / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	75		75		
Form of crediting	~~Examination /~~ crediting with grade*	~~Examination /~~ crediting with grade*	Examination / crediting with grade*	~~Examination /~~ crediting with grade*	~~Examination /~~ crediting with grade*
For group of courses mark (X) final course	X				
Number of ECTS points	3		3		
including number of ECTS points for practical classes (P)			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,28		1,28		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Algebra and Analytic Geometry
2. Mathematical Analysis
3. Introduction to Programming
4. Mathematical Analysis
5. Introduction to Object-Oriented Programming
6. Numerical Methods

or equivalent

SUBJECT OBJECTIVES

C1 To understand basic concepts of modern machine learning (ML) and artificial intelligence (AI)
C2 To understand essential algorithms and architectures in modern ML & AI
C3 To be capable of designing and implementing ML- & AI-based solutions for biomedical engineering problems using modern software platforms

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 understands basic concepts of modern machine learning (ML) and artificial intelligence (AI).
PEU_W02 understands essential algorithms and architectures in modern ML & AI.

relating to skills:
PEU_U01: can design and implementing ML- & AI-based solutions for biomedical engineering problems using modern software platforms.

relating to social competences:
PEU_K01: is capable of communicating and discussing ML- & AI-based solutions for biomedical engineering problems.

PROGRAMME CONTENT

Lecture		Number of hours
Lec 1	Basic concepts and overview of ML & AI	2
Lec 2	Data preprocessing	2
Lec 3-4	Data exploration. Analysis of multidimensional data. Clustering algorithms	4
Lec 5-6	Artificial neural networks: from the perceptron to deep learning	4
Lec 7	Evaluation of AI & ML methods	2
Lec 8	Mid-semester test	2
Lec 9-10	Modeling sequential data. Recurrent neural networks and autoencoders	4
Lec 11	Evolutionary approaches and population-based methods	2
Lec 12	Knowledge representation in AI	2
Lec 13	Visualization and interpretability of AI models	2
Lec 14	Learning problems & techniques: supervised, unsupervised, self- & semi-supervised, reinforcement, transfer learning	2
Lec 15	Final test	2
	Total hours	30

Laboratory		Number of hours
Lab 1	Introduction to AI software platforms	2
Lab 2-3	Data preprocessing	4

Lab 4-5	Data exploration and clustering algorithms	4
Lab 6-7	Convolutional neural networks	4
Lab 8-9	Neural networks for processing sequential data	4
Lab 10-11	Strategies for learning from limited data	4
Lab 12-13	Visualization of AI models	4
Lab 14-15	Ready-made AI-based solutions for biomedical engineering	4
	Total hours	30

TEACHING TOOLS USED
N1. Presentation N2. Individual or small group challenges N3. Hands-on tutorials N4. Assignments N5. Individual or small group assignments

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02	Mid-semester test (written or online)
F2	PEU_W01 PEU_W02	Final test (written or online)
F3	PEU_U01	Indvidual or group assignments
F4	PEU_K01	Participation in challenges
P = (3*F1 + 3*F2 + 5*F3 + F4) / 12 if F3 >= 3.0 else 2.0		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Grus, Joel. (2019). Data Science from Scratch. Sebastopol: O'Reilly Media, Incorporated.
[2] Alppaydin E., Introduction to machine learning, 2-nd ed. The MIT Press, Cambridge, Massachusetts, 2010
[3] Goodfellow, I., Bengio, Y., & Courville, A. Deep Learning. MIT Press (2016) (https://www.deeplearningbook.org)
[4] Géron, Aurélien. (2017). Hands-On Machine Learning with Scikit-Learn and TensorFlow. Sebastopol: O'Reilly Media, Incorporated.
[5] Galea, Alex, & Capelo, Luis. (2018). Applied Deep Learning with Python. Birmingham: Packt Publishing, Limited.

SECONDARY LITERATURE:

[1] Jure Leskovec, Anand Rajaraman, Jeff Ullman. Mining of Massive Datasets (http://www.mmds.org)
[2] Mueller, John Paul, & Massaron, Luca. (2018). Artificial intelligence for dummies (For dummies). Newark: Wiley.
[3] Russell, S., Norvig, P., Davis, E., Edwards, D., Forsyth, D., Hay, N., . . . Thrun, S. (2017). Artificial intelligence: A modern approach (3rd edition; 9th impr., Indian edition. ed.). Noida: Pearson India Education.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr inż. Witold Dyrka (witold.dyrka@pwr.edu.pl)
dr hab. inż. Sebastian Kraszewski (sebastian.kraszewski@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish UKŁADY ZŁOŻONE
Name of subject in English COMPLEX SYSTEMS
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: ~~obligatory~~ / optional / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	75		75		
Form of crediting	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course	X				
Number of ECTS points	3		3		
including number of ECTS points for practical classes (P)			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,28		1,28		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Skills in computer programming and Monte Carlo simulations
2. Knowledge and skills in statistical physics
3. Knowledge and skills in probability theory

SUBJECT OBJECTIVES

C1 Becoming familiar with the concept of complex systems and relations between different approaches used for complex systems
C2 Acquiring knowledge and skills that allow to design, develop, verify, and validate models of complex systems
C3 Acquiring skills to work in the team on the interdisciplinary projects and to present the results of the work to the broad interdisciplinary audience

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 acquiring knowledge related to concept of complex systems and relations between different approaches used for complex systems.

PEU_W02 acquiring knowledge necessary to design, develop, verify, and validate models of complex systems.

relating to skills:

PEU_U01 acquiring skills necessary to design, develop, verify, and validate models of complex systems.

PEU_U02 acquiring skills to work in the team on the interdisciplinary projects and to present the results of the work to the broad interdisciplinary audience.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Introduction: What Is a Complex System? Real-life empirical examples and models.	2
Lec 2	Power-laws in complex systems: Zipf analysis of data in literature, music, urban planning, economy, etc., self-organized criticality.	2
Lec 3-4	Cellular automata: Wolfram's one-dimensional system and universality classes, toy models (e.g., Game of life, Langton's ant) and real-life applications (e.g., modeling traffic jams, etc.).	4
Lec 5-6	Percolation as a simple model of complexity and criticality – Monte Carlo simulations and analytical methods (exact solution on the Bethe lattice, the mean-field and the renormalization group approach).	4
Lec 7-8	Introduction to complex networks – empirical data, basic measures and theoretical models.	4
Lec 9-10	Spreading phenomena on networks – from virus to opinion.	4
Lec 11-12	Agent-based vs analytical model. Advantages and disadvantages of both approaches	4
Lec 13	Tips for building and analyzing model, including a role of averaging (time vs. ensemble average), initial conditions (ordered vs disordered), updating schemes (synchronous vs. sequential) and the type of approach (quenched vs. annealed).	2
Lec 14-15	Agent-based modeling in biology, social science, and economy- theory and applications.	4
	Total hours	30

	Laboratory	**Number of hours**
Lab 1-2	Implementation and visualization of a chosen agent-based model such as the Schelling model of spatial segregation in cities, Reynolds boids, etc.	4
Lab 3	Zipf analysis of selected texts	2
Lab 4-5	Implementation of the selected cellular automata such as the Wolfram's one-dimensional system, Game of Life, Langton Ant, etc.	4
Lab 6-7	Monte Carlo simulations of the percolation model – clusters, paths and criticality	4

Lab 8	Acquiring empirical data from the internet and representing them in a form of a network	2
Lab 9-10	Calculating basic properties of complex networks, including: degree distribution, average degree, shortest path, average path length, clustering coefficients, degree correlations, robustness	4
Lab 11-12	Implementing basic contact processes on graphs	4
Lab 13-15	Designing, developing, verifying and validating models – the team project	6
	Total hours	30

TEACHING TOOLS USED
N1. Lecture with multimedia presentation N2. Team project N3. Discussions, student's presentations N4. Written reports N5. Computer laboratory – programming in C++, Python, Julia, or other programming language N6. Digital resources N7. Consultations

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02 PEU_U01 PEU_U02 PEU_K01 PEU_K02 PEU_K03	discussions, progress check in computer lab
F2	PEU_W01 PEU_W02 PEU_U01 PEU_U02 PEU_K01 PEU_K02 PEU_K03	final presentation and written report related to the team project
P = (F1+F2)/2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] J. Ladyman, K.Wiesner, What Is a Complex System?, Yale University Press (2020)
[2] S. Thurner, R. Hanel, and P. Klimek, Introduction to the Theory of Complex Systems, Oxford University Press (2018)
[3] A. L. Barabási, Network Science, Cambridge University Press (2016)
[4] M. Newman, Networks: An Introduction, Oxford University Press (2010)
[5] J. H. Miller, S. E. Page, Complex Adaptive Systems, Princeton University Press (2007)

SECONDARY LITERATURE:

[1] T. M. Cover, J. A. Thomas, Elements of Information Theory, John Wiley & Sons, Inc. (2006)
[2] N. R. Moloney, K. Christensen, Complexity and Criticality, Imperial College Press 92005)
[3] I. Białynicki-Birula, I. Białynicka-Birula, Modeling Reality, Oxford University Press (2004)
[4] Stephen Wolfram, A New Kind of Science, Wolfram Media (2002)
[5] P. Bak, How Nature Works, Springer (1996)
[6] Original articles

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

prof. dr hab. Katarzyna Weron (katarzyna.weron@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish PROGRAMOWANIE APLIKACJI WIRTUALNEJ RZECZYWISTOŚCI
Name of subject in English VIRTUAL REALITY PROGRAMMING
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: ~~obligatory~~ / optional / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)			30		
Number of hours of total student workload (CNPS)			75		
Form of crediting	Examination / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points			3		
including number of ECTS points for practical classes (P)			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)			1,28		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Practical knowledge of Object-Oriented Programming paradigm.

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SUBJECT OBJECTIVES

C1 Becoming familiar with Unity3D game engine
C2 Gaining basic knowledge of Unity Scripting (C#)
C3 Gaining practical knowledge of Unity Physics and 3D Rendering
C4 Becoming familiar with fundamental concepts of Extended Reality applications
C5 Becoming familiar with multiplatform Extended Reality development with OpenXR
C6 Becoming familiar with applications of Extended Reality in medicine

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 knows basic Unity3D terminology
PEU_W02 knows Unity Scripting C# Syntax
PEU_W03 knows basic concepts of Extended Reality application design and development

PEU_W04 acquires knowledge of Unity Physics and 3D Rendering.
PEU_W05 acquires knowledge of the potential of Extended Reality in medicine.

relating to skills:
PEU_U01 is able to create Unity3D project with Extended Reality support and OpenXR plugin.
PEU_U02 is able to create C# script and implement basic classes, methods and operations on Unity Game Objects.
PUE_U03 is able to test, debug and build any Extended Reality application with Unity3D.
PUE_U04 is able to use Unity Profiler to optimize application.
PUE_U05 is able to implement Extended Reality application in Unity3D at least for one XR headset.

PROGRAMME CONTENT

Laboratory		**Number of hours**
Lab 1	Introduction to Unity3D – basic concepts and project setup	2
Lab 2	Unity Scenes and Objects – creating scenes with basic and imported 3D components.	2
Lab 3	Unity Scripting – creating C# scripts, MonoBehaviour and GameObject concepts	2
Lab 4	Unity UI – introduction to user interface with Unity	2
Lab 5	Unity Rendering – basics of 3D rendering and Unity Camera	2
Lab 6	Unity Physics – introduction to rigid body physics with Unity	2
Lab 7	Unity Platforms and Optimization– basics of multiplatform development, testing, profiling and building applications	2
Lab 8-9	Midterm project – simple 3D game with Unity	4
Lab 10	Introduction to XR – basic concepts	2
Lab 11	XR Camera and Controls – creating XR camera and controls	2
Lab 12	XR UI – design and implementation of user interface dedicated to XR	2
Lab 13-15	XR Medical Project – design and create XR application for medicine	6
Lab 1	Introduction to Unity3D – basic concepts and project setup	2
	Total hours	30

TEACHING TOOLS USED

N1. Computer laboratory – solving tasks
N2. Lab reports
N3. Consultations
N4. Self-study
N5. Digital resources (e-portal PWr)
N6. Quizzes

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02 PEU_W03 PEU_W04 PEU_W05	Quizzes
F2	PEU_U01 PEU_U02 PEU_U03 PEU_U04 PEU_U05	Lab reports
C = max[mean(F1, F2);median(F1,F2)]		

PRIMAY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Lee J J., Hu-Au E., E3XR: An analytical framework for ethical, educational and eudaimonic XR design. Frontiers in Virtual Reality, 2021, 2, 697667.

[2] Technologies, Unity. Unity - Manual: Unity User Manual. https://docs.unity3d.com/Manual/index.html.

SECONDARY LITERATURE:

[1] Morimoto T., Kobayash, T., Hirata H., Otani K., Sugimoto M., Tsukamot, M., Mawatari M. XR (extended reality: virtual reality, augmented reality, mixed reality) technology in spine medicine: status quo and quo vadis. Journal of Clinical Medicine, 2022, 11(2), 470.

[2] Raybourn E. M., Stubblefield W. A., Trumbo M., Jones A., Whetzel J., Fabian, N., Information design for xr immersive environments: Challenges and opportunities. In International Conference on Human-Computer Interaction 2019 (pp. 153-164). Springer, Cham.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr hab. inż. Mirosław Łątka (miroslaw.latka@pwr.edu.pl)
mgr inż. Michał Adamski (michal.adamski@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish PRACA DYPLOMOWA 1
Name of subject in English DIPLOMA WORK 1
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)				10	
Number of hours of total student workload (CNPS)				90	
Form of crediting	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points				3	
including number of ECTS points for practical classes (P)				3	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)				0,40	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

The prerequisites are determined by the thesis advisor.

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SUBJECT OBJECTIVES

C1 Being able to formulate an engineering/research question
C2 Being able to plan and manage own working process

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01: knows and understands at an advanced degree facts and phenomena of Medical Sciences related to Biomedical Engineering, in the fields of Anatomy, Physiology, Propaedeutics of Medical Sciences and Biology

PEU_W02: knows engineering technologies, methods, techniques, tools, and materials used in solving engineering tasks in the field of Biomedical Engineering

relating to skills:

PEU_U01: is able to use analytical, simulation and experimental methods to formulate and solve engineering tasks within the discipline of Biomedical Engineering

PEU_U02: has foreign language skills in the fields of technical sciences and the discipline of Biomedical Engineering

PEU_U03: can plan and organize individual and teamwork

relating to social competences:

PEU_K01: is able to critically evaluate his/her knowledge

PEU_K02: ss able to think and act in an entrepreneurial way, is ready to assess the importance of knowledge in solving cognitive and practical problems

PEU_K03: takes care about the achievements and traditions of the profession

PROGRAMME CONTENT

	Seminar	**Number of hours**
Pr	• Research plan formulation • Research	
	Total hours	

TEACHING TOOLS USED

N1. Computer with Internet connection
N2. Student's own work
N3. Written report

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02 PEU_U01 PEU_U02 PEU_U03 PEU_K01 PEU_K02 PEU_K03	Evaluation of student’s report

P = F1 (advisor's grade)
PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Scientific journals
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
dr hab. inż. Mirosław Łątka (miroslaw.latka@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish PRAWNE I ETYCZNE ASPEKTY INŻYNIERII BIOMEDYCZNEJ
Name of subject in English LEGAL AND ETHICAL ASPECTS IN BIOMEDICAL ENGINEERING
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)					15
Number of hours of total student workload (CNPS)					25
Form of crediting	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points					1
including number of ECTS points for practical classes (P)					1
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)					0,68

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge: general knowledge of engineering technologies, methods, techniques, tools and materials used to solve simple engineering tasks.
2. Competences: understanding the social, economic, and legal determinants of engineering activity.

SUBJECT OBJECTIVES

C1 Understanding the need to follow ethical principles in biomedical engineering activities.
C2 Ability to interpret legal regulations in the field of biomedical engineering.
C3 Getting knowledge about the principles that should be followed in professional work (ethical issues, norms in the health service, norms and standards in biomedical engineering).

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 knows and understands the general principles of creating and developing forms of individual entrepreneurship, using knowledge in the field of science and scientific disciplines appropriate for Biomedical Engineering.

relating to skills:

PEU_U01 is able - when formulating and solving engineering tasks in the field of Biomedical Engineering - to notice their systemic and non-technical aspects.

relating to social competences:

PEU_K01 initiates actions for the benefit of the public interest.

PROGRAMME CONTENT

	Seminar	**Number of hours**
Semin 1	Introduction. Overview of the conditions/rules for completing the course. Proposing your own topic related to the engineering thesis or establishing a different topic for the project (only for students in earlier semesters). Projects are carried out individually.	1
Semin 2-8	Identification of threats to the implementation of engineering works and the possibility of commercialization of the results obtained in the light of applicable law and ethical principles. Each topic should contain a detailed justification of the purpose of the topic, based on local and EU law, and a description of the conditions that must be met in real conditions. Consultation/discussion during the project implementation. Formal presentation of the selected topic by submitting documentation: discussion of the problem/issue, goal(s) and plan of the project implementation, market analysis of existing products and/or services in terms of commercialization of research/implemented projects/services, marketing and strategic analysis - analysis and evaluation of opportunities and market threats, identification and selection of the target market, analysis of products/services existing on the market in terms of existing competition, identification of potential buyers of the product/service.	14
	Total hours	15

TEACHING TOOLS USED

N1. Multimedia presentation
N2. Discussion on a particular topic
N3. Consultations

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
P	PEU_W01 PEU_U01 PEU_K01	Evaluation of a complex project

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] European Commission website on medical devices https://ec.europa.eu/health/md_sector/new_regulations_pl
[2] List of journals (not only in English) corresponding to the keywords bioethics & medical ethics: https://www.gfmer.ch/Medical_journals/Ethics.htm
[3] Selected articles from the journal BMC Medical Ethics https://bmcmedethics.biomedcentral.com/

SECONDARY LITERATURE:

[1] Selected articles from journals (depending on the topic of the seminar): Journal of Medical Ethics, Medical Lasers Applications, Engineering in Medicine and Biology Magazine, IEEE, etc.
[2] Journals assigned to the scientific discipline of biomedical engineering according to the current Annex to the announcement of the Minister of Science and Higher Education
[3] World Health Organization website https://www.who.int/

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr hab. inż. Agnieszka Ulatowska-Jarża (agnieszka.ulatowska-jarza@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish SEMINARIUM DYPLOMOWE
Name of subject in English DIPLOMA SEMINAR
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)					30
Number of hours of total student workload (CNPS)					50
Form of crediting	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points					2
including number of ECTS points for practical classes (P)					2
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)					1,28

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. The student has advanced knowledge and skills in computer science
2. The student has advanced knowledge and skills in electronics and optics

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SUBJECT OBJECTIVES

C1 To learn about new developments and methods used in different applications of medical informatics

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01: knows the basic models and methods used in various applications of medical informatics.

relating to skills:
PEU_U01: is able to prepare and present an oral and multimedia presentation on a given subject related to the subject.

relating to social competences:
PEU_K01 is able to use dedicated scientific literature.

PROGRAMME CONTENT

Seminar		Number of hours
Semin 1	Presentations of results of prepared engineering dissertations by seminar participants	10
Semin 2	Individual presentations concerning the discussion of the current state of knowledge related to the subject of the thesis and relating the anticipated, original own contribution to the literature achievements	10
Semin 3	Discussion in the seminar group on the state of literature knowledge and the assumed conception of solving problems constituting the thesis	10
	Total hours	30

TEACHING TOOLS USED

N1. Problem seminar, presentation, problem lecture, information lecture
N2. Student's own work - preparation for the seminar

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_U01 PEU_K01	Evaluation of a presentation, informative lecture or problem lecture prepared by a student
P = F1		

PRIMARY AND SECONDARY LITERATURE

SECONDARY LITERATURE:

[1] Scientific journals in medical informatics

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr hab. inż. Sebastian Kraszewski (sebastian.kraszewski@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish SZTUCZNA INTELIGENCJA 2
Name of subject in English ARTIFICAL INTELLIGENCE 2
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: ~~obligatory~~ / optional / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	75		75		
Form of crediting	~~Examination /~~ crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course	X				
Number of ECTS points	3		3		
including number of ECTS points for practical classes (P)			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,28		1,28		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Artificial Intelligence 1 or equivalent

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SUBJECT OBJECTIVES

C1 To be acquainted with the current state of the art of artificial intelligence (AI) in biomedical engineering
C2 To be aware of technological and social issues related to application of AI methods to biomedicine
C3 To be capable of conducting the process of development of AI-based software, also as a biomedical product

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 knows the current state of the art of artificial intelligence (AI) in biomedical engineering.

PEU_W02: is aware of technological and social issues related to application of AI methods to biomedicine.

relating to skills:

PEU_U01: is capable of conducting the process of development of AI-based software, also as a biomedical product.

PEU_U02: can document stages of the AI software-related project.

relating to social competences:

PEU_K01 can follow and critically assess ongoing research in AI for biomedical engineering.

PEU_K02 can present and discuss emerging technological and social issues related to application of AI methods to biomedicine.

PROGRAMME CONTENT

Lecture		**Number of hours**
Lec 1	Practical methodology for successful deep learning	3
Lec 2	AI software as a product	3
Lec 3	Current standards for AI in biomedical applications	3
Lec 4	Recent developments in AI for medical imaging	3
Lec 5	Recent developments in AI for medical natural language processing	3
Lec 6	Recent developments in AI for bioinformatics	3
Lec 7	Recent developments in AI for healthcare systems	3
Lec 8	AI in future biomedicine	3
Lec 9	Ethical and legal issues of using AI in biomedicine	3
Lec 10	Selected issue of biomedical AI	3
	Total hours	30

Laboratory		**Number of hours**
Lab 1	Designing workflow	3
Lab 2	Designing AI software as a product	3
Lab 3	Framing a problem and collecting data	3
Lab 4	Understanding data and existing solutions	3
Lab 5	Choosing representation and developing a model	3
Lab 6	Presentation 2	3
Lab 7	Developing a model – continued	3
Lab 8	Evaluating and fine-tuning the model	3
Lab 9	Interpreting and maintaining the model	3
Lab 10	Presentation 2	3

	Total hours	30

TEACHING TOOLS USED

N1. Presentations
N2. Assignments
N3. Group discussions
N4. Individual or small group challenges
N5. Small group projects

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02 PEU_K01 PEU_K02	Assignments & presentations (short reports or position for discussion)
F2	PEU_W01 PEU_W02 PEU_K01 PEU_K02	Active participation in group discussions
F3	PEU_U01 PEU_U02	Completion of tasks in group projects
F4	PEU_W02 PEU_U01 PEU_K01 PEU_K02	Participation in challenges
P = (4 *F1 + 2 *F2 + 5*F3 + F4) / 12 if F1 >= 3.0 and F3 >= 3.0 else 2.0		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Goodfellow, I., Bengio, Y., & Courville, A. Deep Learning. MIT Press (2016) (https://www.deeplearningbook.org)
[2] Alppaydin E., Introduction to machine learning, 2-nd ed. The MIT Press, Cambridge, Massachusetts, 2010
[3] Chollet, F. (2017). Deep Learning with Python. Manning Publications.
[4] Galea, Alex, & Capelo, Luis. (2018). Applied Deep Learning with Python. Birmingham: Packt Publishing, Limited.
[5] Recent scientific literature

SECONDARY LITERATURE:

[1] Géron, Aurélien. (2017). Hands-On Machine Learning with Scikit-Learn and TensorFlow. Sebastopol: O'Reilly Media, Incorporated.
[2] Mueller, John Paul, & Massaron, Luca. (2018). Artificial intelligence for dummies (For dummies). Newark: Wiley.
[3] Russell, S., Norvig, P., Davis, E., Edwards, D., Forsyth, D., Hay, N., Thrun, S. (2017). Artificial intelligence: A modern approach (3rd edition; 9th impr., Indian edition. ed.). Noida: Pearson India Education.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr inż. Witold Dyrka (witold.dyrka@pwr.edu.pl)
dr hab. inż. Sebastian Kraszewski (sebastian.kraszewski@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish ZAAWANSOWANE TECHNIKI OBRAZOWANIA
Name of subject in English ADVANCED IMAGING TECHNIQUES
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: ~~obligatory~~ / optional / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	75		75		
Form of crediting	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	3		3		
including number of ECTS points for practical classes (P)			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,28		1,28		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Knowledge of Medical Imaging Techniques

SUBJECT OBJECTIVES

C1 Becoming familiar with the current state-of-the-art in medical image analysis and imaging

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 knows how to extract, model, and analyze information from medical data and applications to help diagnosis, treatment, and monitoring of diseases.

relating to skills:

PEU_U01 can perform image enhancement, feature extraction and selection, segmentation, and image-based classification.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Toolkits and Software for Developing Biomedical Image Processing and Analysis Applications	2
Lec 2	Biomedical Image Processing	2
Lec 3	Wavelets in Image Processing	2
Lec 4-6	Feature extraction, segmentation, systematic evaluation, and validation on datasets	6
Lec 7-9	Machine learning based approaches for segmentation and classification	6
Lec 10-11	Case studies on some recent advances in analysis of retinal, CT, MRI, ultrasound, and histology images	4
Lec 12-14	Deep Learning for Medical Image Analysis	6
Lec 15	Final test	2
	Total hours	30

	Laboratory	**Number of hours**
Lab 1	Toolkits and Software for Developing Biomedical Image Processing and Analysis Applications	2
Lab 2	Biomedical Image Processing	2
Lab 3	Wavelets in Image Processing	2
Lab 4-6	Feature extraction, segmentation, systematic evaluation, and validation on datasets	6
Lab 7-9	Machine learning based approaches for segmentation and classification	6
Lab 10-11	Case study	4
Lab 12-14	Deep Learning for Medical Image Analysis	6
Lab 15	Final test	2
	Total hours	30

TEACHING TOOLS USED

N1. Traditional lecture
N2. Computer laboratory – solving tasks
N3. Lab reports
N4. Consultations
N5. Self-study
N6. Digital resources (ePortal PWr)
N7. Quizzes

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01	Final test
F2	PEU_U01	Lab reports
F3	PEU_U01	Quizzes
P = F1 (final test on lecture) P = weighted average of F2 and F3 (laboratory)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Deserno, T.M., Biomedical Image Processing, Springer, 2011
[2] Dhawan, A.T., Medical Image Analysis (Second Edition), Wiley 2011
[3] Zhou, K., Medical Image Recognition, Segmentation and Parsing: Machine Learning and Multiple Object Approaches (The MICCAI Society book Series), Academic Press, 2015
[4] Jan, J., Medical Image Processing, Reconstruction and Analysis: Concepts and Methods, Second Edition, CRC Press, 2019

SECONDARY LITERATURE:

[1] Scientific publications
[2] Zhou, K., Greenspan, H., Shen, D., Deep Learning for Medical Image Analysis (The MICCAI Society book Series), Academic Press, 2017

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr inż. Klaudia Kozłowska (klaudia.kozlowska@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish INFORMATYKA W MEDYCYNIE
Name of subject in English COMPUTER SCIENCE IN MEDICINE
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: ~~obligatory~~ / optional / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)					30
Number of hours of total student workload (CNPS)					75
Form of crediting	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points					3
including number of ECTS points for practical classes (P)					3
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)					1,28

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. The student has basic knowledge and skills in computer science.
2. The student has basic knowledge and skills in electronics and optics
3. The student has basic knowledge and skills in mathematical analysis, algebra, organic chemistry, cell biology and biophysics.

SUBJECT OBJECTIVES

C1 To become familiar with methods of numerical design from biological data and to evaluate and analyze the effectiveness of proposed models
C2 Application of chemistry and computational biology methods for the analysis of biophysical processes including molecular processes

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 has knowledge of development trends and the most significant new developments in the field of Biomedical Engineering.

PEU_W02 has theoretically grounded detailed knowledge related to selected issues in the field of information technology methods in medical diagnostics.

relating to skills:

PEU_U01 is able to evaluate the usefulness and applicability of new developments in Biomedical Engineering when formulating and solving engineering tasks.

relating to social competences:

PEU_K01 is ready to critically evaluate the content received.

PROGRAMME CONTENT

	Seminar	**Number of hours**
Semin 1	General introduction to the subject. Rules of the course. Selection of topics.	1
Semin 2	Synthesis, activity analysis, bioassays	2
Semin 3	Mobile health revolution	4
Semin 4	Molecular methods in biology	2
Semin 5	Biomolecular modelling methods in drug discovery	2
Semin 6	Machine learning and artificial intelligence-based methods for medicine	4
	Total hours	15

TEACHING TOOLS USED

N1. Problem seminar, presentation, problem lecture, information lecture
N2. Student's own work - preparation for the seminar

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEK_W01 PEK_W02 PEK_U01 PEK_K01	Evaluation of a presentation, informative lecture or problem lecture prepared by a student
P = F1		

PRIMARY AND SECONDARY LITERATURE
SECONDARY LITERATURE: [1] Scientific journals in medical informatics
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
dr hab. inż. Sebastian Kraszewski (sebastian.kraszewski@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish NOWE TRENDY W TELEMEDYCYNIE
Name of subject in English NEW TRENDS IN TELEMEDICINE
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: ~~obligatory~~ / optional / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)					30
Number of hours of total student workload (CNPS)					75
Form of crediting	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points					3
including number of ECTS points for practical classes (P)					3
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)					1,28

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Basic knowledge and skills in computer science

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SUBJECT OBJECTIVES

C1 Gaining basic knowledge on telemedicine

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 has knowledge of concepts of telemedicine

relating to skills:
PEU_U01: is able to prepare and present an oral and multimedia presentation on a given subject related to the subject.

relating to social competences:
PEU_K01 is able to use dedicated scientific literature.

PEU_K02: is capable discussing telemedicine solutions for biomedical engineering problems.

PROGRAMME CONTENT

Seminar		Number of hours
Semin 1	Introduction	1
Semin 2-8	Examples of telemedicine applications (presentations)	14
	Total hours	15

TEACHING TOOLS USED

N1. Presentation
N2. Student's own work - preparation for the seminar

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEK_W01 PEK_U01 PEK_K01 PEK_K02	Oral presentation
P = F1		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Morgan W., Stotler C., Telemedicine: A Primer, 2018
[2] Gott M., Telematics for health: The role of telehealth and telemedicine in homes and communities, 2018
[3] Rashid T.A., Chakraborty C., Fraser K., (Eds.). Advances in Telemedicine for Health Monitoring: Technologies, design and applications, 2020

SECONDARY LITERATURE:

[1] Scientific journals in telemedicine

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

dr hab. inż. Mirosław Łątka (miroslaw.latka@pwr.edu.pl)
dr inż. Klaudia Kozłowska (klaudia.kozlowska@pwr.edu.pl)

Zał. nr 5 do ZW 16/2020

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY/ DEPARTMENT OF BIOMEDICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish PRACA DYPLOMOWA 2
Name of subject in English DIPLOMA WORK 2
Main field of study (if applicable): BIOMEDICAL ENGINEERING
Specialization (if applicable): MEDICAL INFORMATICS
Profile: academic / ~~practical~~*
Level and form of studies: 1st~~/ 2nd level, uniform magister studies*,~~ full-time / ~~part-time~~*
Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~*
Subject code …….
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)				30	
Number of hours of total student workload (CNPS)				300	
Form of crediting	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	~~Examination~~ / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points				12	
including number of ECTS points for practical classes (P)				12	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)				1,28	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

It is required to pass the following course: Diploma work 1.

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SUBJECT OBJECTIVES

C1Being able to plan and manage own working process
C2 Being able to present and defend results of thesis

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01: knows and understands at an advanced degree facts and phenomena of Medical Sciences related to Biomedical Engineering, in the fields of Anatomy, Physiology, Propaedeutics of Medical Sciences and Biology

PEU_W02: knows engineering technologies, methods, techniques, tools, and materials used in solving engineering tasks in the field of Biomedical Engineering

relating to skills:

PEU_U01: is able to use analytical, simulation and experimental methods to formulate and solve engineering tasks within the discipline of Biomedical Engineering

PEU_U02: has foreign language skills in the fields of technical sciences and the discipline of Biomedical Engineering

PEU_U03: can plan and organize individual and teamwork

PEU_U04: is able to provide a consistent, well-structured and -argued text of thesis

relating to social competences:

PEU_K01: is able to critically evaluate his/her knowledge

PEU_K02: ss able to think and act in an entrepreneurial way, is ready to assess the importance of knowledge in solving cognitive and practical problems

PEU_K03: takes care about the achievements and traditions of the profession

PROGRAMME CONTENT

	Seminar	**Number of hours**
Pr	• Completing research • Preparing the draft of the thesis • Revision of the draft.	
	Total hours	

TEACHING TOOLS USED

N1. Computer with Internet connection
N2. Student's own work
N3. Thesis

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 PEU_W02 PEU_U01 PEU_U02 PEU_U03 PEU_U04 PEU_K01	Thesis

	PEU_K02 PEU_K03	
P = F1 (advisor's grade with respect to reviewer's opinion)		

PRIMARY AND SECONDARY LITERATURE
<u>PRIMARY LITERATURE:</u> [1] Scientific journals
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
dr hab. inż. Mirosław Łątka (miroslaw.latka@pwr.edu.pl)